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RECONSTRUCTION OF CHIN DEFECT POST BASAL CELL CARCINOMA EXCISION USING RHOMBOID FLAP: A CASE REPORT

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ABSTRACT

Introduction: Basal cell carcinoma (BCC) is a malignant skin tumor with the highest incidence and originates from the basal cells of the epidermis, with the nodular type being the most common.
Case Illustration: A 76-year-old female patient came with complaints of a lump on the chin that had enlarged and bled easily for 3 years before entering the hospital. The patient was diagnosed with Basal Cell Carcinoma in the chin region.
Discussion: Wide excision was performed under local anesthesia, then the wound was closed with a rhomboid flap. Evaluation after 1 month post-operatively the wound closed well and the scar was disguised.
Conclusion: The chin is a unique aesthetic area with unique contours and shapes, making it a challenge for plastic surgeons to perform reconstruction after extensive BCC excision. The rhomboid flap is a very versatile local flap because it can be used almost anywhere on the body, including the chin.

Highlights:

1. BCC is strongly associated with UV radiation exposure,commonly affecting the face, but the chin is rarely involved (1.2% incidence).
2. Chin reconstruction after BCC excision is challenging, requiring careful flap selection for function and aesthetics.
3. The rhomboid flap is a preferred choice, offering good blood supply, minimal tension, quick healing, and better cosmetic results.

INTRODUCTION

Basal cell carcinoma (BCC) is a malignant non-melanocytic skin tumor that originates from the epidermal layer of the skin, most often accounting for 65-75% of skin tumor cases. In Indonesia, BCC ranks as the third most common cancer, following breast and cervical cancer.[1] Basal cell carcinoma occurs in body parts that are often exposed to direct sunlight such as the head, neck, trunk and legs. It occurs more often in people over 40 years of age than in young people.[2]

Basal cell carcinoma (BCC) is a critical concern in both dermatology and oncology due to its high prevalence, potential for local tissue destruction, and the necessity for early intervention. As the most common skin cancer worldwide, BCC accounts for approximately 75%–80% of all non-melanoma skin cancers and is strongly associated with chronic ultraviolet (UV) radiation exposure, genetic predisposition, and environmental factors, making prevention and early detection essential.[3,4] Although BCC rarely metastasizes, it can cause extensive local invasion, particularly in high-risk areas such as the face, scalp, and neck, often necessitating complex surgical excision and reconstruction.[5] Advanced cases may require reconstructive techniques, such as the rhomboid flap, to restore both function and aesthetics, posing a significant challenge for reconstructive and aesthetic surgeons. Additionally, oncological approaches, including targeted therapy with hedgehog pathway inhibitors, play a crucial role in managing inoperable or metastatic cases.[6] Given its clinical impact, continuous research, improved screening, and multidisciplinary collaboration are essential to enhance patient outcomes and optimize treatment strategies.

Basal cell carcinoma is more common in men than women. [1,7] Basal cell carcinoma has 5 subtypes, including nodular, pigmented, superficial, ulcerative, and morpheaform. The nodular subtype is the most common subtype found in almost 72 percent of BCC cases with clinical features in the form of papules or translucent nodes, telangiectasia, and rolled borders. [1,8,9]

BCC is most commonly found in the Caucasian race followed by Asians and blacks. Several studies have suggested that the relationship between the number of melanocytes in the body affects the incidence of skin tumors because melanin's function is to prevent damage from exposure to UV rays.[2]

BCC arises from both genetic and environmental factors, with UV radiation being a major etiological trigger. Environmental contributors include hydrocarbons, arsenic, coal, tar, and topical methoxipsoralen, but UVB exposure plays the most significant role. The highest incidence of BCC occurs near the equator, while Finland has the lowest rates. UV radiation inflicts both acute and chronic damage acutely, it causes DNA mutations that disrupt proto-oncogene and tumor suppressor gene synthesis, while chronically, it leads to photoaging, immunosuppression, and photocarcinogenicity. UV-B, the primary endogenous chromophore, not only damages DNA but also affects molecular targets in the cytoplasm and cell membrane, altering antigen-presenting functions of Langerhans cells and leading to immunosuppression. Additionally, UV-B exposure has been linked to TP53 tumor suppressor gene mutations, contributing to BCC pathogenesis.[1.8, 10]

Epidemiological data and histopathological analysis of BCC in Asia, including Indonesia, remain limited, highlighting the need for further research and awareness.[11] BCC presents significant challenges for dermatologists and reconstructive aesthetic surgeons. Its diverse clinical manifestations, potential for local tissue invasion, and complex surgical management make early detection and appropriate treatment crucial. Moreover, the limited data hinder the development of standardized guidelines for diagnosis and optimal management, emphasizing the urgent need for increased focus on BCC in both research and clinical practice.

One of the key challenges in BCC treatment, particularly for cases involving extensive excision, is the selection of an appropriate reconstruction technique to restore both function and aesthetics. The rhomboid flap is a highly versatile local flap that can be used almost anywhere on the body, including the chin, which is a unique anatomical and aesthetic region. Given the thick skin and complex contours of the chin, achieving optimal wound closure with minimal scarring requires careful planning. The rhomboid flap offers reliable vascularization, good skin texture and color match, and a single-stage procedure, making it a preferred choice for BCC reconstruction in this area.

CASE ILLUSTRATION

A 76-year-old female patient came with a complaint of a mass on her chin that had been growing and bleeding easily for 3 years before entering the hospital, which was painful and itchy. If it bleeds, the wound is difficult to heal. On physical examination of the patient's chin, a blackish mass was found with ulceration in the middle, irregular edges measuring 2x2 cm. It was painful to the touch. Laboratory examination was within normal limits. On histopathological examination measuring 2 x 1.5 x 1.3 cm, a nodular type of Basal Cell Carcinoma was found consisting of basaloid cell proliferation, round oval nuclei, pleomorphic, hyperchromatic, forming a nodular pattern with peripheral palisading, infiltrative in the fibrocollagen stroma. The patient was diagnosed with Basal Cell Carcinoma of the chin region and a wide excision was performed with a margin of 3-4 mm of healthy tissue under local anesthesia, after which the wound was closed with a rhomboid flap. The flap was attached using polyglicolycacid 4/0 and Polypropylene 6/0, the sutures were removed 5 days after surgery. Evaluation after 1 month post-operatively the wound closed well and the scar was disguised. Further follow-up is needed to assess wound healing and recurrence.

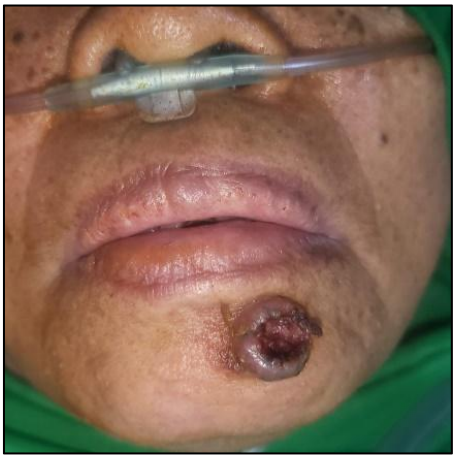

Figure 1. Basal Cell Carcinoma on the Chin

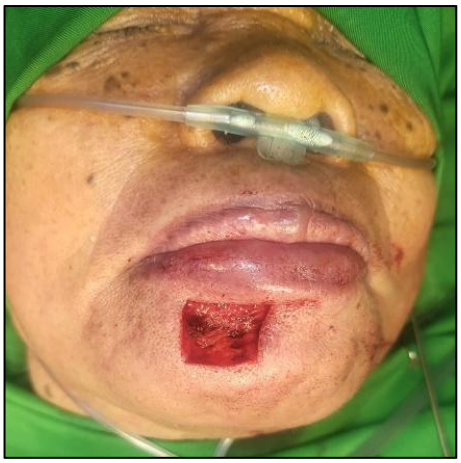

Figure 2. Post-Surgical Excision Defect

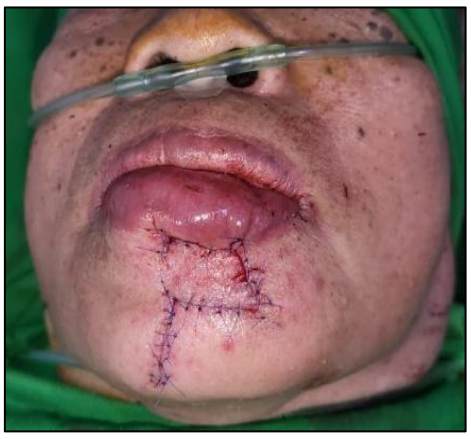

Figure 3. Rhomboid Flap

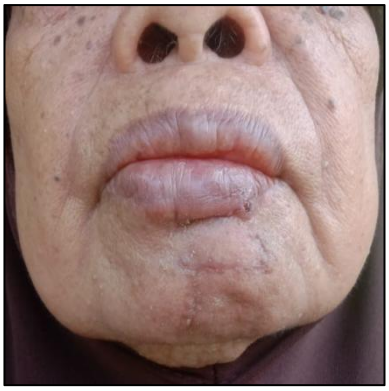

Figure 4. One-Month Postoperative Wound Condition

Figure 5. Nodular Basal Cell Carcinoma

DISCUSSION

Basal cell carcinoma is the most common skin cancer in the world. In the United States, affecting almost 3 million people each year, which is in second place, while in first place is Australia. The incidence of BCC in Singapore is very small during a 48-year observation of around 14,441 cases. Basal cell carcinoma is a nonmelanocytic skin malignancy originating from nonkeratinizing cells of the basal layer of the epidermis which is most often associated with UV radiation causing genetic mutations. [8,9,12-14]

Many studies have established a strong link between UV exposure and the incidence of basal cell carcinoma (BCC), identifying UV radiation as a primary etiological factor in non-melanoma skin cancer. This correlation is evident in global epidemiological patterns, with BCC being most prevalent in regions near the equator, while countries like Finland report the lowest incidence rates in Europe. UV radiation contributes to BCC development by damaging DNA and impairing its repair mechanisms, leading to genetic mutations that promote uncontrolled cell growth and tumor formation. UV-B radiation, in particular, plays a critical role in this process, as it is readily absorbed by DNA and induces specific forms of damage, such as cyclobutane pyrimidine dimers and 6-4 photoproducts. These mutations, especially those affecting the TP53 tumor suppressor gene on chromosome 17p13.1, have been linked to BCC initiation and progression. Beyond direct genetic damage, UV radiation also alters cellular functions by targeting molecular structures in the cytoplasm and cell membrane, including cell surface receptors, kinases, phosphatases, and transcription factors. Additionally, UV-B exposure disrupts immune function by impairing the antigen-presenting role of Langerhans cells, leading to local immunosuppression and further increasing susceptibility to tumor development.Understanding the mechanisms by which UV radiation induces carcinogenesis, from DNA damage to immune modulation, is essential for improving prevention strategies and developing more effective treatments for BCC.[1,10,15,16]

BCC is closely related to UV radiation so that anatomically the parts of the body that are often exposed to UV rays are the head, neck, trunk and legs. The face is the most common predilection area, especially the nose and cheeks. The chin is one of the parts of the face that rarely experiences BCC, the incidence is only 1.2%.[12] This unique anatomical location poses distinct challenges for reconstruction after tumor excision, as the chin has thick skin with less elasticity, which can lead to increased tension during closure and potential poor scarring.

The chin is a unique aesthetic area with unique contours and shapes, making it a challenge for plastic surgeons to reconstruct

after extensive BCC excision. The chin is the part of the face with the thickest skin, which can lead to poor scarring.[17]

In basal cell carcinoma (BCC) management, determining the appropriate surgical excision margin is crucial to minimize recurrence rates. As a general guide, adequate surgical margins are 3–4 mm for a BCC and at least 4 mm for a low-risk SCC. [18-22] Regarding reconstruction post-excision, the rhomboid flap is a versatile option for closing surgical defects resulting from BCC excision. Its design allows for effective tension distribution and satisfactory cosmetic outcomes, making it suitable for various facial regions, including the chin. Combining an adequate excision margin with a rhomboid flap reconstruction can enhance both oncologic safety and aesthetic results in BCC treatment. [23]

In this case, the patient presented with a 2×2 cm ulcerated, pigmented nodular BCC on the chin, a relatively uncommon location. The lesion's size and irregular borders necessitated a wide excision with a 3–4 mm margin of healthy tissue to ensure complete tumor removal. However, a wide excision in the chin region risks significant functional and aesthetic impairment, particularly affecting lower lip mobility and symmetry if not reconstructed properly.

Mohs micrographic surgery, the gold standard for BCC treatment, was unavailable due to resource limitations. The success rate of Mohs Micrographic Surgery (MMS) in treating primary basal cell carcinoma (BCC) measuring less than 2 cm is 99%.[24] Therefore, a wide excision followed by reconstruction using a rhomboid flap was chosen to achieve optimal oncologic clearance while preserving function and aesthetics.

Mohs micrographic surgery in this case could not be performed due to limited resources, so a wide and deep excision was performed in the hope that all the tumor tissue had been removed. Large defects in the chin can affect the upper cutaneous lip and vermilion border which when repaired with inappropriate technique and design can cause significant functional impairment.[4,7,25,26]

Hedgehog pathway inhibitors (HPIs) are targeted therapies that effectively inhibit the Hedgehog signaling pathway, which plays a crucial role in the development of basal cell carcinoma (BCC). This pathway is typically inactive in adult tissues, but mutations in the PTCH1 or SMO genes cause abnormal activation, driving BCC growth. Several HPIs, including vismodegib and sonidegib, have been approved and are clinically used to treat locally advanced BCC (laBCC) and metastatic BCC (mBCC) that are inoperable or unresponsive to other treatments. The use of HPIs such as vismodegib and sonidegib for BCC on the chin depends on the patient's clinical condition. HPIs are generally used for locally advanced or metastatic BCC that cannot be surgically removed due to large tumor size, deep tissue infiltration, or a high risk of surgical complications. However, if BCC on the chin can still be excised with proper surgery, reconstruction using techniques such as the rhomboid flap is often the preferred option, as it provides good aesthetic and functional outcomes. HPIs are more recommended in cases where the lesion is too large or deep, the patient has contraindications for surgery, or excision cannot be performed with adequate margins. The Hedgehog inhibitor vismodegib has been approved for the treatment of locally advanced and metastatic BCC. The most common side effects associated with approved HPIs include muscle spasms, dysgeusia (taste disturbances), and alopecia (hair loss). Additionally, patidegib, which is still under investigation, is being developed as a topical formulation to reduce systemic side effects, while itraconazole and arsenic trioxide have also shown potential in inhibiting the Hedgehog pathway. HPIs offer new hope for patients with advanced BCC, but challenges such as significant side effects, drug resistance, and high costs remain barriers to their widespread use. Therefore, further research is needed to enhance the effectiveness of this therapy, whether

through the development of new formulations or combination treatments with other therapeutic approaches.[27-34]

There are many methods that can be done in BCC reconstruction on the chin including full thickness skin grafts, secondary intention healing, and flap options. The flaps that can be used are local flaps such as bilobed, rhomboid, platysmal and V-Y advancement flaps.[8,18,35] Several studies have shown that the rhomboid flap has been successfully used for chin defect reconstruction. Some studies mention that the rhomboid flap has been used for reconstructing defects in the cheek, temple, lips, ears, nose, chin, eyelids, and neck.[36-40] Additionally, the rhomboid flap has become a popular reconstructive alternative for facial defects in recent years.

The advantages of local flaps are Reliable blood supply, Good skin texture and color match, A single stage procedure. In determining the flap used in BCC reconstruction on the chin, plastic surgeons must pay attention to important principles of reconstruction, including: Incision and closure should be along relaxed skin tension lines (RSTLs), Closure should be tension-free, Flaps should consider function and aesthetic subunits. Minimizing the risk of distortion in adjacent structures like the lower lip. Additionally, as a local flap, it maintains good texture and color match with the surrounding skin, offering superior aesthetic integration compared to grafts. By considering these principles, the rhomboid flap was chosen.[8,35,36,40]

The rhomboid flap is a local flap that has a parallelogram shape with two 60 degree angles and two 120 degree angles, also called the Limberg flap, which rotates at pivot point X, which is vascularized by the subdermal or subpapillary plexus, in large flaps by the perforator vascular supply. Placing the incision parallel to the skin relaxation lines (RSTL) allows the resulting scar to be within the skin fold along the line of maximum extensibility and results in a more minimal scar. [37,41,42]

The advantages of the rhomboid flap are that the procedure is easy and fast, the design is simple, minimally invasive, can be performed with local anesthesia, can reduce tension, secondary defects can be disguised with RSTL, and healing is rapid. Reconstruction using the rhomboid flap maintains continuity of texture, color, thickness, and vascularity with the surrounding tissue so that function and aesthetics can be met. The rhomboid flap is a very versatile local flap because it can be used almost anywhere on the body. [41,43,44]

This case the surgery was performed under local anesthesia, and the rhomboid flap was secured with polyglycolic acid 4/0 and polypropylene 6/0 sutures. The sutures were removed after 5 days, and the wound healed well without signs of infection or necrosis.

At the 1-month follow-up, the wound had closed completely with good aesthetic results, and the scar was well camouflaged within the chin contour. The patient did not report any significant functional impairments, such as restricted lower lip movement or excessive scar contracture. Further regular follow-up is essential (every 6–12 months for 3–5 years) to monitor for potential recurrence, although the recurrence rate of BCC after complete excision is generally low.[8]

This case presents several notable strengths. The comprehensive surgical approach ensured a balance between oncologic tumor removal and optimal reconstructive outcomes. The selection of the rhomboid flap was based on anatomical, functional, and aesthetic considerations, allowing for proper tension distribution, minimizing distortion of adjacent structures, and providing superior healing outcomes compared to skin grafting. Additionally, postoperative results showed good wound healing without complications such as infection or necrosis, with the scar well-camouflaged within the chin contour and no significant functional impairment of the lower lip.

However, there are some limitations in this report. One limitation is the lack of long-term evaluation, as follow-up was conducted only for one month. Given that BCC carries a risk of long-term recurrence, monitoring over 3–5 years is necessary to ensure no recurrence occurs. Moreover, this report is based on a single case, making the findings less generalizable. Further evaluation through larger case series or prospective studies would provide stronger evidence regarding the effectiveness of the rhomboid flap in BCC reconstruction of the chin.

In terms of novelty, this case provides insight into the challenges of reconstructing a rarely affected BCC location, the chin, which has thicker skin and limited elasticity. Additionally, this report highlights that wide excision with a rhomboid flap can be an effective alternative for healthcare centers without access to Mohs micrographic surgery, without compromising functional or aesthetic outcomes. The use of the rhomboid flap for chin reconstruction following BCC excision is also rarely reported, making this study a valuable contribution to further understanding optimal reconstruction techniques for this uncommon location.

This case report provides important insights into the surgical management of BCC in the chin region, demonstrating the effectiveness of a rhomboid flap in preserving function and aesthetics. While long-term follow-up and larger case studies are needed, the findings contribute to alternative treatment strategies in resource-limited settings and expand knowledge on reconstructive options for rare BCC locations.

CONCLUSION

BCC on the chin is a rare but challenging condition that requires careful surgical planning to ensure both oncologic safety and aesthetic-functional outcomes. In this case, the rhomboid flap proved to be a reliable reconstructive option, allowing for tension-free closure, good cosmetic integration, and preservation of chin mobility. This case highlights the importance of individualized surgical approaches in facial BCC reconstruction, particularly in areas with complex anatomical and aesthetic considerations.

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CONFLICT OF INTEREST

The authors declare no conflict of interest related to this study. No financial, personal, or institutional affiliations influenced the research, analysis, or conclusions presented in this article.

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AUTHOR CONTRIBUTION

YMT contributed to the conceptualization, data collection, manuscript drafting, and final approval of the manuscript. SDS supervised the study, critical revision of the manuscript and approved the final version. Both authors have thoroughly reviewed and reached an agreement on the final version of the manuscript.

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PEDICLED ABDOMINAL FLAP FOR MALIGNANT DEFECT RECONSTRUCTION: A VIABLE ALTERNATIVE TO FREE FLAP

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ABSTRACT

Introduction: The pedicled abdominal flap, a commonly used reconstructive option, remains relevant in the era of advanced microsurgery despite the rising preference for free flaps. While free flaps offer advantages, they also carry risks of flap failure and require complex microvascular anastomosis, making them less suitable for certain patients.
Case Illustration: A 48-year-old female with a non-healing chronic ulcer over the left upper arm, secondary to burn scarring from a flame burn 20 years ago, underwent tumor resection and debridement with full-thickness tissue loss. A pedicled axial fasciocutaneous flap based on paraumbilical perforators was taken from the left lumbar abdominal region and used to close the defect.
Discussion: This case report highlights the use of the pedicled abdominal flap in the reconstruction of defects resulting from malignancy, emphasizing its reliability and suitability in such complex scenarios. For individuals with malignancy, the pedicled abdominal flap is often favored due to its safer, single-stage procedure, minimizing complications and re-operation risks.
Conclusion: Compared to free flaps, the pedicled abdominal flap is a preferable choice in reconstructing defects in cancer patients due to its reliability, reduced risk of flap failure, and relatively simple surgical procedure. This is particularly important for cancer patients, where the focus is on achieving functional reconstruction while considering patient's prognosis.

Highlights:

1. Pedicled abdominal flap remains a reliable reconstructive option in the era of microsurgery.
2. Although a two-stage procedure, it provides safe and functional reconstruction.
3. Compared to free flaps, it offers a simpler approach with fewer complications, which is crucial for cancer patients with limited prognosis.

INTRODUCTION

In the era of continuously developing microsurgery, free flaps have gained preference replacing pedicled abdominal flap. However, with better aesthetic outcomes, free flaps still carry the inherent risk of flap failure (up to 10%) which can lead to significant complications.[1] On the other hand, the pedicled abdominal flap, although needs two stage reconstruction, is often preferred in certain patient populations, particularly those with malignancy. It offers a safer option than performing microvascular anastomosis, which requires greater technical expertise and carries higher risk of thrombosis.[2] In such clinical contexts, surgical decision-making often prioritizes the mitigation of complications, given that free flap procedures are linked to a greater incidence of flap loss, increased reoperation rates, and prolonged recovery periods.

Although pedicled abdominal flaps have been extensively utilized in reconstructive surgery, recent literature offers limited insight into their specific advantages for oncologic patients, particularly those with advanced malignancies who may be suboptimal candidates for free flap procedures due to significant comorbidities, limited life expectancy, or tumor-related constraints. Comprehensive comparative studies examining long-term outcomes, functional results, and complication rates between pedicled abdominal flaps and free flaps remain scarce, especially in the context of malignancy-related reconstruction outside the head and neck region.[3]

This case report aims to address these gaps by highlighting the role of pedicled abdominal flaps in the reconstruction of defects resulting from malignancy, focusing on their reliability, safety, and functional outcomes in a cohort that may not be suitable for free flap procedures. By presenting a detailed examination of this approach, we hope to establish that the pedicled abdominal flap remains an essential tool in oncologic reconstruction, offering a valuable alternative in specific patient populations in the era of advanced microsurgery.

CASE ILLUSTRATION

A 48-year-old female presented with a history of a non-healing ulcer over the left upper arm due to burn scarring from a flame injury sustained 20 years prior. The burn scar, initially stable, began to ulcerate and enlarge progressively over several years despite routine modern wound dressing measures. Clinical examination revealed an ulcerated lesion with irregular margins and induration, suggestive of malignancy (Figure 1).

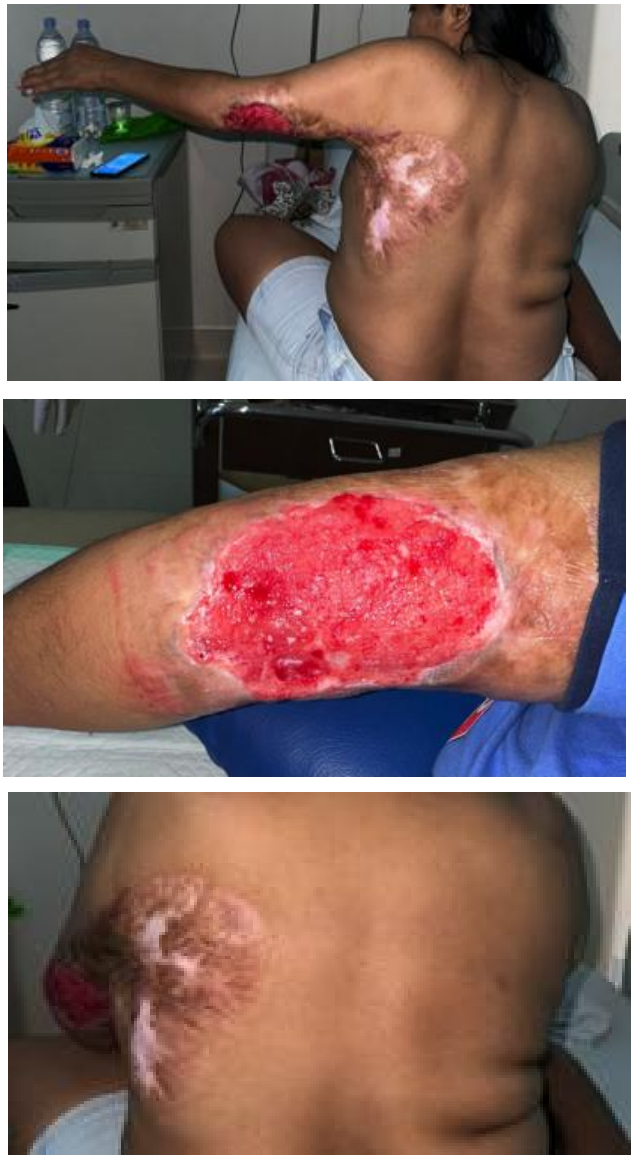

Figure 1. Initial Defect of The Left Upper Arm

The patient underwent a biopsy, and histopathological examination revealed a well-differentiated squamous cell carcinoma, classified as not otherwise specified (NOS). Based on this diagnosis, the surgical oncology team planned a wide excision with a 1–2 cm safety margin to ensure complete tumor removal. Considering the potential for a significant tissue defect following resection, the patient was referred to the plastic surgery department for collaborative surgery to perform wound closure and reconstruction.

Following tumor resection, debridement of the defect was done which showed complete loss of skin, subcutaneous tissue, and fascia of the upper arm. A rectangle-shaped skin flap was designed on the left abdominal region on the same side as the defect on the affected upper arm. A pedicled abdominal flap was harvested from the left lumbar area of the abdomen, utilizing the paraumbilical perforators for vascularity. Theoretically, the flap can be located anywhere as long as it is designed above the central axis of the lateral abdomen area, so the position of the flap should be determined according to the area that is to be covered.[4] A split-thickness skin graft was harvested from the left thigh and applied to cover the donor site on the abdominal wall following flap harvest. Subsequently, the patient's upper arm was positioned against the abdomen and carefully immobilized using a splint, dressing, and plaster to maintain stability and support the healing process (Figure 2).

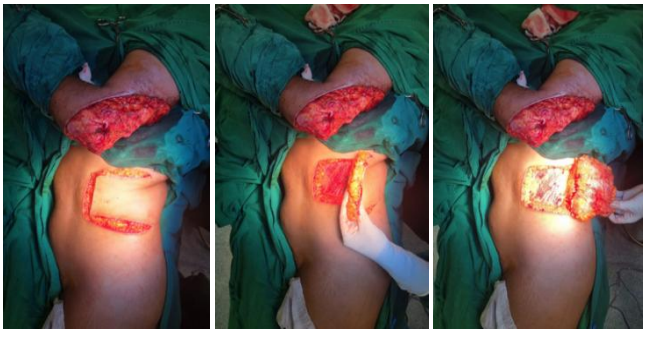

Figure 2. Flap Harvest and Immediate Postoperative Result

A follow-up examination five days post-operatively revealed that the flap remained viable and patient was discharged. The flap remained in place for three weeks, and then followed by another surgery for flap divison. After being divided, the flap showed reliable viability, with rapid capillary refill time, skin color demonstrated good tissue perfusion, wound dehiscence was not present, and skin graft healed well (Figure 3).

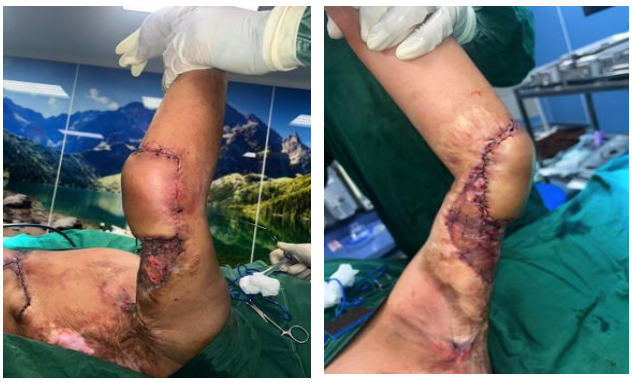

Figure 3. Flap Division 3 Weeks Post-Operatively

At 1 month follow-up, flap showed successful healing with stable soft tissue coverage across the entire left upper arm, and the donor at left abdomen showed complete epithelialization. Skin graft showed acceptable take nearing 95% viability, with remaining raw surface treated with regular wound care (Figure 4).

Figure 4. One month Post-Operative Of Flap And Donor Site

Patient then underwent radiotherapy to decrease risk of recurrence. At 3 month follow-up, the flap remains viable, the raw surface of previous skin graft has greatly reduced in size, and is covered by granulation tissue (Figure 5). Patient showed normal range of motion in the left upper extremity and was satisfied with the long-term outcomes. We did not get the 6 month and 1 year data since she did not come for another follow up.

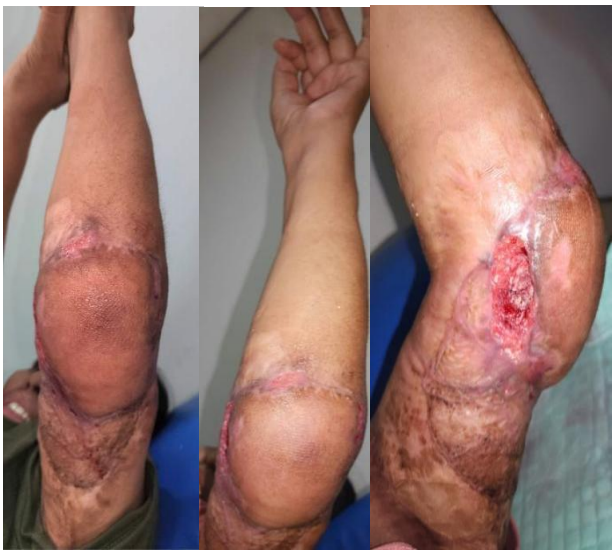

Figure 5. 3 Month Post-Operative Shows Flap Remains Viable

DISCUSSION

Our case posed a challenge due to the upper extremity defect, requiring preservation of the patient's range of motion. The defect was extensive, with complete soft tissue loss, making skin grafts and local flaps unsuitable. Given the patient's history of well-differentiated squamous cell carcinoma and uncertain metastatic risk, microsurgical free flap reconstruction was deemed unnecessary, as its risks, such as prolonged surgery and potential flap loss could outweigh the benefits.

In cancer patients, selecting the right reconstructive approach is crucial for balancing function, aesthetics, and overall health. Since malignancy often shortens life expectancy and increases metastatic risk, a reliable, low-risk reconstruction is preferred. The pedicled abdominal flap is particularly advantageous for large defects, providing durable coverage with minimal surgical burden.

The pedicled abdominal flap relies on an established vascular anatomy, typically from the paraumbilical perforators, which ensures a predictable and robust blood supply compared to free flaps.[5] This vascular consistency reduces the risk of flap failure, a significant concern in cancer patients who may already have poor

perfusion or systemic factors, such as cachexia, malnutrition, or chemotherapy effects that compromise wound healing and flap viability.[6] Given that free flaps are more susceptible to complications such as thrombosis or venous congestion, which could necessitate reoperation, the pedicled abdominal flap minimizes the need for additional surgeries. This consideration is particularly relevant for patients with advanced malignancy, where further surgical interventions may pose additional risks.[7]

The pedicled abdominal flap is frequently used to repair defects in areas such as the upper extremity, chest wall, or abdominal wall, with the flap's size and shape easily customized to fit different defect requirements.[8] The relatively straightforward procedure of harvesting and shaping the abdominal flap makes it an appealing option, particularly in settings where advanced microvascular techniques or facilities may not be available.[9] Additionally, cancer patients often experience compromised immune function due to treatments such as chemotherapy or radiation therapy, which can impair wound healing and increase susceptibility to infections.[10] The pedicled abdominal flap, with its reliable blood supply and less complex surgical requirements, is associated with a lower incidence of wound-related complications compared to free flap procedures[11]. This simplicity is especially beneficial for patients who may not tolerate prolonged surgical times or the risks associated with microsurgical techniques.[12]

In this case, it was shown that the pedicled abdominal flap is a simple and effective reconstructive option. It is simpler, does not require microvascular anastomosis, and can be performed even in resource-limited settings.[13] The bulky nature of the flap is particularly advantageous for reconstruction around the elbow joint. It provides adequate soft tissue padding, which is critical in this area to prevent pressure points and wound breakdown. Furthermore, in our case, the flap did not require secondary thinning, as its volume was well-suited to the defect and provided sufficient coverage without compromising the range of motion. Another notable advantage was the rapid wound healing observed, which was important in this patient who required further radiotherapy. The reliable healing and early recovery allowed timely continuation of the patient's oncologic treatment, minimizing delays in the overall management plan.

There are inherent limitations with the use of a pedicled abdominal flap in upper extremity reconstruction. One of the most significant challenges is patient discomfort due to the positioning required during the initial period of flap insetting and integration. The need to maintain the arm in a flexed position, often attached to the abdomen for several weeks, can be uncomfortable and may lead to patient dissatisfaction. Prolonged immobilization carries the risk of elbow stiffness or contracture, which necessitates careful physiotherapy post-detachment.[14] Additionally, the morbidity at the donor site, including potential for wound complications, scarring, or delayed healing at the abdominal area, must be considered. Another limitation is the requirement for a two-stage procedure, as flap division and insetting typically need to be performed after an initial period of vascular ingrowth, prolonging the total treatment duration and potentially adding to the patient's overall surgical burden.[15]

Studies comparing pedicled flap and free flap in oncologic patients are limited especially in upper extremity reconstruction. In a systematic review on head and neck cancer, patients underwent pedicle flap has shorter surgery time, ICU and hospital stay, with lower cost. However, it has higher rate of any complications although there are variations across studies. Flap failure and necrosis happened in 31% cases of pedicled flap compared to 4% on free flap group (p 0.02). Partial necrosis happens in lesser

extent (11% vs 2.8%). Infection and wound dehiscence were observed in 17% and 10% in pedicled flap compared to 3% and 0% in free flap, respectively.[16] A small study (n=38) on upper extremity sarcoma showed that pedicled flap resulted in higher complications (55.6% vs 5%; p 0.00), yet without significant differences on infection or flap loss (11.1% vs 0%).[17]

This case highlights the novelty of utilizing a pedicled abdominal flap for extensive upper extremity reconstruction in a cancer patient who required a balance between oncologic safety and functional preservation. While pedicled abdominal flaps have been traditionally used in various reconstructive scenarios, their application in this context offering a simple, robust, and timely solution without delaying adjuvant therapy demonstrates an adaptable approach in complex oncologic reconstruction. While the pedicled abdominal flap offers a reliable, simple, and effective solution for large soft tissue defects in the upper extremity, particularly in oncologic patients, careful consideration of patient selection, postoperativemanagement, and potential complications is essential to optimize outcomes. Moreover, The pedicled abdominal flap is a safe option, especially in centers without microsurgical backup. It saves operating time and minimizes donor site morbidity. Postoperative monitoring is required to ensure flap viability.

Future studies are required to compare the long-term outcomes of pedicled abdominal flaps with free flaps, particularly in upper limb reconstruction in cancer patients. Such studies are essential to determine not only functional and aesthetic outcomes but also complication rates, patient satisfaction, and quality of life. Multicenter trials involving heterogeneous patient groups, large numbers of patients, and longer follow-up will provide more robust and generalizable data. Moreover, comparative investigations can determine patient-specific variables affecting flap selection and guide individualized reconstructive planning. Lastly, such efforts will pave the way for the formulation of evidence-based practice guidelines that optimize outcomes in this difficult-to-treat population.

Table 1. Comparison of Pedicled Flap (PF) and Free Flap (FF) in Oncologic Reconstruction [15-22]

Parameter	Pedicled Flap (PF)	Free Flap (FF)
Operative Time	Shorter (mean: 6h 53m)	Longer (mean: 9h 18m)
ICU & Hospital Stay	Shorter ICU (0.1–1 d); shorter hospital stay (esp. SMIF/SCAIF)	Longer ICU (1.4–2 d); longer hospital stay
Cost	Lower	Higher
Availability & Feasibility in Resource-Limited Settings	High; suitable without microsurgery	Limited; needs specialized infrastructure
Technical Demand	Less demanding	Requires microvascular expertise
Postoperative Complications	Higher overall; flap loss (31%), infection (17%), dehiscence (10%)	Lower overall; flap loss (4%), infection (3%), dehiscence (0%)
Functional & QoL Outcomes	Acceptable; lower scores in speech/social; suitable for moderate defects	Superior; better scores in function, speech, emotion; preferred for large/complex defects
Recovery Time	Faster initial wound healing	Slower wound healing, but better long-term function
Donor Site Morbidity	Present (e.g., abdominal wall, PMMF)	Variable (e.g., RFFF, ALT)
Versatility & Defect Coverage	Good for small–moderate defects; limited for >70 cm^2	Excellent for large, composite, 3D defects
Suitability in Comorbid Patients	Safer; less invasive	Riskier in patients with high CCI (>4)
Aesthetic Outcomes	Acceptable	Often superior with better contouring

CONCLUSION

Compared with free flap reconstruction, the pedicled abdominal flap continues to serve as a dependable and effective alternative for addressing soft tissue defects in cancer patients, particularly those with compromised systemic health or advanced-stage malignancies. This technique inherently reduces surgical risk, lowers the incidence of flap failure, and provides a more accessible reconstructive option, especially in clinical environments where microsurgical expertise is limited. Given these advantages, the pedicled abdominal flap warrants consideration for a wider spectrum of both oncologic and non-oncologic reconstructive applications. Future research should prioritize the evaluation of long-term functional outcomes, patient-reported quality of life measures, and the continued optimization of flap design to enhance surgical success while minimizing donor site morbidity.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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The authors declare that no funding was received for this study.

AUTHOR CONTRIBUTION

BK contributed to the investigation, writing, and data curation for this study. PTU was responsible for the conceptualization, writing, and data curation. Both authors collaborated closely throughout the research process and contributed significantly at every stage, from investigation to manuscript preparation.

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PRESSURE INJURY PATIENTS CHARACTERISTIC IN SOUTH EAST INDONESIA WARRANTS IMMEDIATE INITIATION OF PREDICTIVE ASSESSMENT TOOLS: A CHART REVIEW

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ABSTRACT

Introduction: Pressure injury (PI) is a worldwide health problem, a burden in many aspects, and influences life quality. Every PI case would be different due to several underlying factors and conditions which hindered the prevention strategies. We share the overview of PI patients on South East Indonesia.
Method: A descriptive-retrospective study with chart review approach was held to review all case of PI consulted to plastic surgery from 2021-2023. Basic demographic data was collected along with the wound area, PI stage, and referrer department.
Result: PI was more frequent in Male patients insignificantly (p=0.069) developed more PI (55.13%) than female patients (44.87%). Almost half of PI case occurred in patients with more than 60 years old of age (48.71%). Most case were referred by the internal medicine, pulmology and cardiology department (43.59%) and mostly located in sacral region, (64.10%). Unstageable PI was found the most (48.72%) while no stage 1 PI was consulted.
Discussion: The study validates known pressure injury risk factors such as sensory and motor deficits and immobility. The absence of stage 1 PI highlights the need for the implementation of standardized assessment tools and prompt detection strategies. Visual inspection, palpation on a daily basis, and education to caregivers during discharge planning are needed to reinforce prevention.
Conclusion: PI incidence corresponds with known risk populations. Hospital leadership should implement predictive PI assessment tools and incorporate PI education into discharge planning to improve early detection and intervention.

Highlights:

1. The absence of Stage 1 pressure injuries reflects the need for a predictive assessment tool.
2. The majority of patients were aged 60–71 and had unstageable pressure injuries.
3. The main referring departments were Internal Medicine, Cardiology, and Pulmonology.

INTRODUCTION

Pressure injury (PI) is a global concern, impacting quality of life, society, and healthcare management. Previously known as pressure sores, pressure ulcers, or decubitus ulcers, PI is defined as a localized injury to underlying tissue over a bony prominence due to prolonged pressure, often in combination with shear forces. It can also be associated with medical devices or other objects.[1] The injury results from reduced capillary perfusion due to constant pressure, excess moisture, and shear stress.[2] Although impaired perfusion is the primary pathological mechanism, no single factor is solely responsible for the development of pressure injuries. Risk factors include, but are not limited to, patient age, inactivity, immobility, a history of vascular disease, diabetes, skin moisture, and nutritional status.[3]

According to the National Pressure Injury Advisory Panel NPIAP, pressure injuries are classified into four stages, with two additional categories: unstageable and deep tissue pressure injuries.[4] Globally, 12.8% of hospitalized adult patients experience pressure injuries. In Indonesia, the prevalence is 8%, with 44% of patients already having them upon admission. Nosocomial pressure injuries account for 4.5%.[5]

Certain populations are at a higher risk of developing pressure injuries. Palliative care patients, for instance, have a reported incidence of 71.1%.[1,6] The development of PI before or during hospital admission increases healthcare costs. A U.S. study analyzing the national cost burden of hospital-acquired pressure injuries (HAPI) estimated an average cost of $10,708 per patient.[7] In Indonesia, a stroke unit reported an all-stage PI risk of 28%, higher than the 12.2–20.3% risk observed in general inpatients.[8] As a preventable burden, PI prevention should involve not only healthcare workers but also home caregivers, utilizing predictive assessment tools.[9]

Pressure injuries (PI) is crucial as it impacts patients' quality of life, increases healthcare costs, requires better prevention strategies, helps evaluate intervention effectiveness, and improves care standards to prevent serious complications. Patients with pressure injuries (PI) experience a decreased quality of life (QoL), limited activity and mobility, social isolation, emotional issues, and persistent pain. QoL reflects the functional impact of a disease and is considered an indicator of unmet needs. Additionally, it is used to assess the effectiveness of healthcare services, nursing interventions, and cost-benefit analyses. QoL is influenced by an individual's perspective on life satisfaction and can change over time. The effectiveness of PI treatment, which has a significant global impact, is evaluated through QoL indicators.[10-13]

The main goal of pressure injury treatment is to improve quality of life. Treatment options include surgical sharp debridement and autolytic debridement, with the choice depending on the patient's overall condition.

In this study, we reviewed the characteristics of pressure injury patients in our tertiary referral hospital. Previously, PI data was not regularly recorded because its incidence was no longer a mandatory hospital report. The aim of this study is to present the characteristics of PI over a three-year observation period and describe current issues in PI prevention strategies at our hospital. This study provides insights into the burden of pressure injuries, focusing on sex, age distribution, staging, referral sources, and the severity of anatomical regions affected. Additionally, it highlights the challenges in PI management, particularly in the absence of predictive assessment tools. This research aligns with the STROBE initiative.[14]

METHODS

This descriptive study utilized a chart review approach to analyze all cases of

pressure injuries recorded in the plastic surgery registry at the Department of Surgery from January 1st, 2021 to December 31st, 2023, at a tertiary referral hospital in East Nusa Tenggara, Indonesia. Data were collected retrospectively using medical records.

The inclusion criteria encompassed all pressure injury patients in the hospital who were referred for consultation with the plastic surgery department. Patients who declined consultation and/or passed away before undergoing a plastic surgery examination were excluded. This study examined sex, age distribution, staging, referral sources, and the anatomical regions affected by pressure injuries.

Diagnosis and staging of pressure injuries were determined by plastic, reconstructive, and aesthetic surgeons based on the National Pressure Injury Advisory Panel (NPIAP) classification (Table 1).[1]

Table 1. The Classification of Pressure Injury[1]

Classification	Definition
Stage 1	Intact skin with non-blanchable redness over a localized area on a bony prominence.
Stage 2	Partial-thickness loss of dermis, presenting as a shallow open ulcer or a serum-filled blister without bruising or slough.
Stage 3	Full-thickness loss of dermis with exposed subcutaneous fat. The injury does not expose tendon, muscle, or bone. Often presents with epibole (rolled wound edges) and slough.
Stage 4	Full-thickness loss of dermis with exposed or directly palpable tendon, muscle, or bone. Often presents with slough and eschar.
Unstageable	Full-thickness ulcer with slough or eschar completely covering the wound base, preventing assessment of its true depth until the covering material is removed.
Deep tissue injury	Purple or maroon discoloration with intact skin, caused by underlying tissue damage.
Device – related pressure injury	Injury resulting from prolonged pressure applied by medical equipment or everyday objects.
Mucosal membrane pressure injuries	Pressure injuries occurring on moist mucosal surfaces due to sustained compressive and shear forces from medical devices.

Univariate and bivariate data were analyzed using the open-source PSPP software. This study was approved by the Universitas Nusa Cendana Ethical Committee (No: 342/UNIS.21/TU/2024).

RESULTS

Based on our registry, there were seventy-eight cases of pressure injury consultations over a three-year period. The average age was 51.44 (22.12) years for males and 60.2 (19.12) years for females. Male patients accounted for 55.13% of cases, while female patients made up 44.87%, though the difference was not statistically significant ($p > 0.069$) (Table 2).

Table 2. Sex Distribution

Sex	Frequency	%
Male	43	55.13
Female	35	44.87

Age distribution analysis revealed that pressure injuries were most common in older adults, with the highest prevalence in the 61-70 age group (25.64%), followed by 51-60 years (19.23%) and 71-80 years (14.10%). In contrast, younger patients (< 40 years) were less frequently affected, comprising only 23.07% of cases. Notably, the proportion of cases increased with age, peaking in the 61-70 age group, suggesting that aging is a significant risk factor for pressure injuries (Table 3).

Most cases were classified as unstageable (48.72%), followed by Stage 2 (21.79%), Stage 4 (17.95%), and Stage 3 (11.54%), with no cases categorized as Stage 1 (Table 4). This indicates that a significant proportion of pressure injuries were already advanced or difficult to classify upon consultation.

Table 3. Age Distribution

Age Group (years old)	Frequency	%
< 20	6	7.69
21 - 30	5	6.41
31-40	7	8.97
41-50	7	8.97
51-60	15	19.23
61-70	20	25.64
71-80	11	14.10
> 80	7	8.97

Table 4. Staging Distribution

Stage	Frequency	%
Stage 1	0	0
Stage 2	17	21.79
Stage 3	9	11.54
Stage 4	14	17.95
Unstageable	38	48.72

Regarding referral sources, the majority of cases (43.59%) were referred from the internal medicine, cardiology, and pulmonology departments, followed by neurology and neurosurgery (25.64%), oncology (17.95%), surgery and urology (8.97%), and obstetrics and gynecology (3.85%) (Table 5). This distribution suggests that pressure injuries were more prevalent among patients with chronic or debilitating conditions, particularly those with cardiovascular, pulmonary, and neurological diseases.

In terms of anatomical distribution, more than half of the cases (64.10%) were located in the sacral region, making it the most common site of pressure injuries. Other affected areas included the gluteal region (11.54%), the major trochanter of the femur (6.41%), and various other regions (5.13%), with 12.82% of cases involving multiple sites (Table 6). This finding highlights the sacrum as the primary pressure injury site, likely due to prolonged immobility and sustained pressure in bedridden patients.

These results are consistent with previous studies that identify the sacral area as highly vulnerable in patients with limited mobility. The bony prominence and superficial soft tissue cushioning in this area leave sacral area vulnerable to tissue damage due to pressure. Understanding this distribution pattern is critical for certain preventative practices, which involve regular turning and use of pressure redistributing devices.

Table 5. Referer Department Distribution

Referer Department	Frequency	%
Internal Medicine, Cardiology, & Pulmonology	34	43.59
Neurology & Neurosurgery	20	25.64
Obstetrics & Gynaecology	3	3.85
Oncology	14	17.95
Surgery & Urology	7	8.97

Table 6. Anatomic Region Distribution

Anatomic Region	Frequency	Percent
Gluteal	9	11.54
Sacrum	50	64.10
Major Trochanter of Femur	5	6.41
Other Region	4	5.13
Multipel Site	10	12.82

DISCUSSION

Historically, in 1777, the term “decubitus” was coined by Wohlleben, referring to “dead tissue due to lying down.” In 1859, Florence Nightingale documented the term “bedsore,” which later became widely used. The term “pressure sore” gained popularity in the 1980s, followed by “pressure ulcer,” which became commonly used in the early 1990s. Nowadays, the term “pressure ulcer” is still being used in European meanwhile the term “pressure injury” is now more popular in South-East Asia, Australia, and New Zealand.[1]

The term “ulcer” does not include deep tissue injuries and stage 1 pressure injuries because these conditions involve intact skin. Therefore, in April 2016, the National Pressure Injury Advisory Panel (NPIAP) officially replaced “pressure ulcer” with “pressure injury”. [15] This change redefined “deep tissue pressure injury” and “stage 1” as

injury stages that do not involve soft tissue ulceration. Additionally, the revised terminology introduced "medical device-related pressure injury" and "mucosal membrane pressure injury" as specific causes of pressure injuries, rather than staging classifications.[1,15]

The current NPIAP classification system categorizes pressure injuries based on the visual appearance and extent of skin tissue damage (Table 1). The exact stage of a pressure injury is determined through visual inspection and palpation of the wound, based on the anatomical level of skin involvement.

The pathophysiology of pressure injuries occurs due to prolonged pressure, friction, and shear forces that reduce blood flow (ischemia), leading to oxygen deprivation and ultimately cell death. Prolonged pressure on bony areas compresses blood vessels, restricting the supply of oxygen and nutrients to the tissues. If the pressure is not relieved, ischemia develops and begins to damage the tissue. Additionally, shear and friction worsen the condition by damaging the skin and underlying tissue, making it more susceptible to injury. Oxygen deprivation triggers inflammation, causing swelling that further impairs blood flow. If the pressure continues, cells begin to die (necrosis), which can progress to open wounds and infection. If left untreated, pressure injuries will worsen, progressing from early stages of redness and irritation to involving deeper tissues and bone. Therefore, prevention is crucial, including frequent repositioning, maintaining skin hygiene, and using support devices to reduce pressure.[16]

Pressure injuries occur due to ischemia, which happens when external pressure exceeds capillary pressure, leading to impaired capillary blood flow.[2] Immobility is the most significant risk factor, making intensive care unit (ICU) patients and spinal cord injury (SCI) patients particularly vulnerable to developing pressure injuries (PI) due to their impaired sensory and motor function. It is estimated that the incidence of PI development in ICU patients can be as high as 40% during hospitalization.[17] Among SCI patients, one PI case is found for every three SCI patients.[18]

Besides ICU and SCI patients, obese individuals are also considered at risk of PI development, although this remains a topic of debate. The increased shear and friction experienced when moving or getting out of bed is thought to contribute to this risk. [1,19,20] Additionally, children and neonates have been reported to be at high risk of developing PI, primarily due to nutritional deficiencies and prolonged use of medical devices in neonatal intensive care units (NICU).[21]

Regarding sex distribution, male patients (55.13%) were more frequently affected than female patients (44.87%) (Table 2). This pattern may be influenced by differences in muscle mass, mobility, and comorbidities that predispose men to a higher risk of PI.

In our study, PI distribution was higher in older age groups, with the majority of cases occurring in individuals aged 61–70 years (25.64%), followed by 51–60 years (19.23%) and 71–80 years (14.10%) (Table 3). We believe this finding aligns with the effects of aging on skin integrity. As people age, the skin becomes more fragile and heals more slowly, a process further exacerbated by comorbidities and other predispositions.[22] Notably, younger patients (<40 years) accounted for only 23.07% of cases, indicating that PI is more prevalent in older individuals. Additionally, the proportion of PI cases increased with age, peaking in the 61–70 years group, suggesting that aging is a significant risk factor.

A significant number of PI cases (43.59%) were referred from the internal medicine, cardiology, and pulmonology departments, followed by neurology and neurosurgery (25.64%) (Table 5). This trend may be explained by prolonged bedridden status, limited physical activity, and sensory impairment in patients with systemic and neurogenic conditions. A similar pattern has been observed in other Indonesian hospitals, where PI predominantly affects patients with

diabetes, neurogenic disorders, and respiratory conditions.[5]

The findings of this study indicate that the majority of pressure injury (PI) cases were diagnosed at the unstageable stage (48.72%), followed by Stage 2 (21.79%), Stage 4 (17.95%), and Stage 3 (11.54%), with no recorded cases at Stage 1 (Table 4). The absence of Stage 1 cases suggests a lack of early recognition and delayed consultation, as skin discoloration without an open wound is often overlooked. Additionally, the absence of a standardized predictive assessment tool, such as the Braden Scale, forces healthcare providers to rely solely on subjective clinical judgment, increasing the risk of underdiagnosis and delayed intervention in the early stages. Without a systematic early screening method, high-risk patients,such as those in the ICU, individuals with neurological disorders, or those with systemic comorbidities are more vulnerable to the progression of PI to more severe stages. Consequently, hospitals face an increased burden of care, more complex patient complications, and prolonged hospital stays. Therefore, the implementation of evidence-based predictive tools is an urgent necessity to enhance early detection and prevent PI progression.

In terms of anatomical distribution, the sacral region (64.10%) was the most commonly affected site, likely due to prolonged immobility and sustained pressure in bedridden patients. Other affected areas included the gluteal region (11.54%), major trochanter of the femur (6.41%), and various other regions (5.13%), while 12.82% of cases involved multiple sites (Table 6). These findings emphasize the importance of pressure redistribution strategies, particularly for high-risk anatomical sites.

The goal of surgical intervention is to close the wound, either through flap surgery or surgical debridement, to promote wound healing. However, in this study, most PI patients were unsuitable for surgical debridement or flap surgery due to severe clinical conditions, such as hemodynamic instability. As a result, autolytic debridement was performed in almost all cases of unstageable PI with severe or critically ill conditions to maintain the patient's overall stability.Another alternative treatment to autolytic debridement is negative pressure vacuum therapy. Unfortunately, this option is not available in our region.

A pressure injury prediction tool is an instrument used to assess a patient's risk of developing pressure injuries, allowing healthcare professionals to implement preventive measures earlier. These tools evaluate various risk factors such as mobility, moisture, sensory perception, activity level, and nutritional status. Early identification of at-risk patients enables timely interventions, such as repositioning, pressure-relieving devices, and skin care management, to reduce the incidence of pressure injuries. Regular reassessment using these tools is essential, especially for hospitalized and long-term care patients, to ensure ongoing preventive care. Several commonly used assessment tools include the Braden Scale, Norton Scale, Waterlow Scale, and Cubbin & Jackson Scale.[23]

The Braden Scale evaluates various factors contributing to pressure injury risk, including sensory perception, moisture levels, activity, mobility, nutritional status, and friction/shear forces. The maximum score on this scale is 23, with risk categories as follows: a score of 20 or higher indicates low risk, 16-20 represents moderate risk, 11-15 signifies high risk, and a score below 10 indicates very high risk.[24] This tool is widely used in clinical settings due to its reliability and ease of use in identifying at-risk patients. Regular assessment with the Braden Scale allows healthcare providers to implement targeted preventive measures, such as pressure redistribution strategies and specialized support surfaces, to reduce the likelihood of pressure injuries.

Tabel 7. Braden Scale for Predicting Pressure Injury Risk[25]

Category	1	2	3	4
Sensory Perception *(ability to respond to discomfort and pressure)*	**Completely Limited:** Unresponsive to pain, decreased consciousness, or under sedation. **Or** Limited ability to feel pain across most of the body.	**Very Limited:** Responds only to pain, unable to communicate discomfort except by moaning or restlessness. **Or** Sensory impairment that limits pain perception in half of the body.	**Slightly Limited:** Responds to verbal commands but cannot always communicate discomfort or needs assistance to reposition. **Or** Minor sensory impairment affecting one or two extremities.	**No Impairment:** Responds to verbal commands, no sensory deficit limiting pain or discomfort perception.
Moisture *(degree of skin exposure to moisture)*	**Constant Moisture:** Skin remains consistently moist due to sweat, urine, etc.; detected every time the patient is moved.	**Frequently Moist:** Skin is often but not always moist; linens need changing at least once per shift.	**Occasionally Moist:** Skin is occasionally moist, requiring extra linen changes about once per day.	**Rarely Moist:** Skin is rarely exposed to moisture, requiring only routine linen changes.
Activity *(level of physical activity)*	**Bedfast:** Confined to bed.	**Chairfast:** Severely limited or no ability to walk, unable to bear weight, must be assisted to a chair or wheelchair.	**Walks Occasionally:** Walks short distances during the day with or without assistance but spends most of the time in bed or a chair.	**Walks Frequently:** Walks outside the room at least twice daily and inside the room at least once every 2 hours while awake.
Mobility *(ability to change and control body position)*	**Completely Immobile:** Unable to make even slight movements without assistance.	**Very Limited:** Occasionally makes slight changes in body position but cannot make frequent or significant changes without help.	**Slightly Limited:** Frequently makes slight changes in body position without assistance.	**No Limitations:** Able to make frequent and significant position changes independently.
Nutrition *(daily food intake pattern)*	**Very Poor:** Rarely finishes meals, eats <1/3 of each meal, consumes <2 protein servings per day, poor fluid intake, or only receives water/IV fluids for >5 days.	**Probably Inadequate:** Usually eats only half of served meals, gets only 3 protein servings per day, occasionally takes supplements, or receives minimal enteral feeding.	**Adequate:** Eats more than half of meals, consumes 4 protein servings per day, occasionally refuses food but generally takes supplements when offered, or receives enteral feeding/TPN covering most nutritional needs.	**Excellent:** Eats nearly all meals served, never refuses food, usually eats between meals, does not require supplements.

The Norton Scale was the first tool developed to assess and monitor pressure injury risk. It evaluates five key factors: physical condition, mental status, activity level, mobility, and incontinence. Each category is scored, with a total score ranging from 5 to 20. A score below 14 indicates that a patient is at "risk" for developing pressure

injuries, with lower scores signifying higher risk. However, this scale has limitations in identifying risks among patients with more complex health conditions.[23]

The Waterlow Score is a more comprehensive tool that considers factors such as age, body weight, mobility, skin condition, nutritional status, and underlying medical conditions that may increase the risk of pressure injuries. This tool assesses ten variables and categorizes risk levels as moderate risk (10–14 points), high risk (15–19 points), and very high risk (>20 points). Its main advantage lies in its ability to accommodate a broader range of clinical factors, making it more accurate for patients with complex medical conditions.[26]

The Cubbin & Jackson Scale is specifically designed for patients in intensive care units (ICU). It evaluates factors that are particularly relevant to critically ill patients, including the level of consciousness, vascular access device (VAD) use, body temperature, oxygen saturation, hemodynamic and respiratory conditions, presence of edema, prone positioning, and length of ICU stay. The total score ranges from 10 to 40, with 10–26 classified as high risk and 27–40 as low risk. This scale is particularly beneficial for ICU patients who have unique care requirements that differ from those of general hospital patients.[27]

The use of pressure injury prediction tools is essential in clinical practice, as they enable healthcare professionals to identify at-risk patients early and implement effective preventive measures. Interventions such as frequent repositioning, the use of low-pressure mattresses, specialized cushions, and optimal skin care can significantly reduce the incidence of pressure injuries. Additionally, these tools help optimize resource allocation by ensuring that interventions are targeted at the highest-risk patients, thereby improving care efficiency.

Several studies have demonstrated varying levels of accuracy among these prediction tools. The Braden Scale, one of the most widely used, has been shown to have a sensitivity of 88.2% and a specificity of 72.7%, making it an effective tool for detecting pressure injury risk across different patient populations.[28] Therefore, implementing these predictive tools not only contributes to pressure injury prevention but also enhances healthcare quality by reducing complications, accelerating patient recovery, and lowering hospital care costs overall.

A predictive assessment tool is recognized as one of the key strategies for preventing pressure injuries (PI). [29-31] It is beneficial in reducing PI incidence and delaying its onset by assessing risk factors. [30,31] Unfortunately, our health center has not yet implemented any predictive tool system. The absence of such a tool prevents caregivers from systematically assessing and recognizing PI risk, making it difficult to plan specific preventive treatments. As a result, interventions are often delayed and primarily curative rather than preventive. By implementing a predictive assessment tool, risk factors could be evaluated for each new inpatient, allowing for the early development of targeted prevention strategies.

Currently, the Braden Scale (BS) is the most commonly used predictive assessment tool in more than 30 countries and has been translated into multiple languages. [32] Among various predictive tools, the Braden Scale has the highest predictive value. [33–35] The Braden Scale consists of six subscales that assess sensory perception, mobility, nutritional status, activity level, moisture exposure, and friction/shear forces. A lower score indicates a higher risk of developing PI, requiring greater attention and preventive measures. The Braden Scale is recommended for use alongside clinical judgment. [32] For patients with low scores in immobility, repositioning strategies should be prioritized. Similarly, for those with poor nutritional status, a specific dietary plan should be considered to improve their overall condition and reduce PI risk.

Some of the pressure injuries (PI) encountered in this study developed outside the hospital, a finding consistent with several other studies. [5,36] Singh and Shoqirat (2021)

reported that only 11% of PIs originated from post-acute care settings. [37] This highlights the low level of knowledge regarding PI prevention among family members and home caregivers. In community-dwelling older adults, factors such as physical limitations, comorbidities, and cohabitation increase the risk of developing PI.[36-38]

Community-Acquired Pressure Injury (CAPI) emphasizes the need for comprehensive education for family caregivers in home care settings. Integrating continuous care training—including wound identification, wound prevention, proper wound care, repositioning and mobilization techniques, and dietary principles—into discharge planning could significantly improve both PI prevention and patients' psychological well-being. [39,40]

Despite the absence of a formal predictive assessment tool such as the Braden Scale (BS), nurses and physicians in our study were able to diagnose PI early and refer cases to plastic surgery. This represents a strength of the study, as it demonstrates the capability of healthcare providers to conduct early PI screening based on clinical expertise alone.

The strengths of this study include the ability of healthcare providers to diagnose pressure injuries (PI) early despite the absence of a formal predictive assessment tool like the Braden Scale (BS), as well as its consistency with known PI risk factors such as advanced age, ICU admission, spinal cord injury (SCI), and systemic diseases. However, limitations exist, including the inability to assess prior wound care quality before referral, the lack of predictive tools in the healthcare facility, and the retrospective nature of the study, which may limit data accuracy. This study is its reliance on chart review, which may not fully capture all PI cases due to incomplete or inconsistent documentation. This limitation suggests that some early-stage PI cases, particularly stage 1, could have been underreported or overlooked in medical records. Future studies should incorporate direct clinical assessment or prospective data collection to ensure more comprehensive and accurate identification of PI cases.

The novelty of this study lies in highlighting the failure to diagnose early-stage PI due to the absence of predictive assessment tools, emphasizing the urgent need for their implementation. Furthermore, it sheds light on the lack of education for home caregivers, contributing to the high incidence of Community Acquired Pressure Injury (CAPI). These findings underscore the necessity of integrating predictive PI assessment tools into hospital protocols and developing comprehensive education programs for both healthcare providers and family caregivers.

We believe that some unseen factors may have caused the high number of unstageable PIs found in our study, aside from the absence of predictive tool implementation. We were also unable to obtain information on prior wound care provided by the caregiver. This may be related to the severity of the PI, thus reflecting the limitation of this study. However, the fact that unstageable PI was mostly found during consultation was enough to raise awareness to implement the predictive tool assessment and to emphasize a continuous education for home care-settings as soon as possible.

CONCLUSION

The majority of cases we encountered were unstageable pressure injuries, primarily referred by the internal medicine, cardiology, and pulmonology departments. Autolytic debridement can be considered the preferred treatment option for critically ill patients with unstageable PI. The absence of a predictive assessment tool is believed to be the main contributing factor to these findings. We strongly encourage hospital leadership to implement a predictive PI assessment tool for all inpatient admissions. Additionally, for this patient population, an educational program should be established to inform family caregivers about the importance of PI

prevention, ensuring it is integrated into discharge planning.

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CONFLICT OF INTEREST

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AUTHOR CONTRIBUTION

All of the authors have contributed to conceptualization, data Acquisition, analysis of data, manuscript writing, and final approval of manuscript.

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PROFILE OF KELOID PATIENTS IN SURGICAL WOUNDS: A STUDY AT DEPARTMENT OF PLASTIC AND RECONSTRUCTIVE SURGERY, DR. SOETOMO GENERAL ACADEMIC HOSPITAL, SURABAYA, INDONESIA (2019-2022)

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ABSTRACT

Introduction: Keloid formation is an abnormal scarring process resulting from disruptions in wound healing. Clinically, keloids extend beyond the original wound margins and progressively enlarge into dense, firm nodules. They can develop following various forms of trauma, including surgical procedures. Several factors contribute to keloid formation in surgical wounds, including age, gender, genetics, skin color, hormones, incision location, wound tension, and delayed healing.

Methods: This retrospective descriptive study analyzes medical records of patients diagnosed with keloids due to surgical wounds at the Department of Plastic and Reconstructive Surgery, Dr. Soetomo General Academic Hospital, Surabaya, between 2019 and 2022.

Results: Among 58 keloid patients, 23 developed keloids following surgery. The most common risk factor was a history of previous keloid surgery. The majority of patients were female, aged 17–25 years, students, and had no family history of keloids. The most frequent keloid location was the chest, with an onset of ≥1 year, a size of <20 cm^2, and associated itching. Surgical excision and combination therapy were the most commonly used treatment approaches.

Conclusion: A history of previous keloid surgery is the primary risk factor for keloid formation in surgical wounds. Surgery and combination therapy remain the most frequently employed treatment strategies.

Highlights:

1. Previous keloid surgery mostly caused keloid recurrence.
2. The most common symptom that accompanies keloids in surgical wounds was itching.
3. Surgery and combination therapy were the most used therapy.

INTRODUCTION

Keloid is a condition characterized with an abnormality in wound healing process. [1] During the wound healing process, myofibroblasts that participate in skin contractions enter the process of apoptosis. Lack of apoptosis in myofibroblasts and excessive accumulation, leads to the occurrence of excessive inflammation and the lifting of scars. [2] Keloids grow over the skin beyond the border of the initial lesion, and become larger over time as dense, supple nodules. Keloid scars may cause psychological and social impacts that can reduce the quality of life. Keloids can be accompanied with symptoms such as pain, itching, and contracture.[3] Study conducted at the Faculty of Medicine, Udayana University, as many as 48% of students with keloids had a mild influence on their quality of life. [4] The most common causes that start wounds in keloid are tattoos, acne, burns, injections, insect bites, piercings, vaccinations, abscesses, and surgical procedures.

The incidence of keloids can be estimated to be around 5-10% in Africa, 0-0.1% in Asia, and <0.1% in other countries.[5] It is evaluated that about 100 million individuals around the world developed scars from surgery or trauma. As many as 15% of these scars are abnormal scars such as keloids.[3] Of the 5,774 patients operated on 33 surgical facilities in Zambia between 1993 and 2008, 514 of them developed into keloids. [6] Keloids accounted for almost 9% of all surgical cases in Zambia in 1993-2008. [7] Research conducted in Nothern India, found 107 cases of keloids, and 17.8% of them appeared due to postoperative wounds. The incidence of keloids in Asia is recorded at 0.1% in Japan and 0.15% in Taiwan.[8] In China, a study conducted in 2018-2021 found that the most common causes of keloids were trauma and surgery with the same number at 24.7%. [9] In Indonesia, retrospective studies reported 93 cases in Manado, 56 cases in Surabaya, and 157 cases in Padang between 2011 and 2018.[8-10] At Dr. Soetomo General Academic Hospital in 2014 until 2017, 17.86% of keloid patients were found to be caused by postoperative wounds.[11]

Although most surgical wounds heal without complications, several factors contribute to keloid formation, including age, gender, genetics, skin color, hormones, incision location, wound tension, and delayed healing.[5] Keloids in surgical wound present a significant challenge in clinical practice due to their high chance of recurrence. In the prevention of postoperative scarring, one of the most critical factors that can be modified is wound tension. This is determined by the choice of incision technique, which is to make an incision by following the relaxed skin tension line. In addition, good postoperative wound care management is important for the first three months to produce optimal wound healing, so that it can heal within the expected period of time without complications such as keloids. [12] Adverse wound healing conditions such as infection, wound depth, delayed wound healing and excessive wound tension, are known to be associated with keloid growth.[6]

Keloids resulting from surgical wounds pose a significant clinical challenge due to their high recurrence rate, treatment difficulties, and associated discomfort. Unlike other types of wounds, surgical incisions are often subject to high tension, which contributes to excessive scar formation. Even with surgical excision, keloids frequently return, often growing larger than before, necessitating additional treatments such as corticosteroid injections, laser therapy, or radiation.

Patients with keloids from surgical wounds commonly experience pain, itching, and contractures, particularly if the keloid forms in areas with high mobility, such as joints. This can lead to functional limitations, making everyday movements uncomfortable or restricted. Additionally, keloids can cause significant cosmetic and psychological distress, impacting the patient's self-esteem and quality of life.

Given the high recurrence risk and difficulty in management, preventing keloid

formation in surgical wounds is crucial. This includes using proper surgical techniques (e.g., incisions along relaxed skin tension lines), postoperative wound care, and adjuvant therapies such as silicone gel sheets or pressure dressings to minimize excessive scar formation.

Based on the background regarding the number of keloid cases that occur due to surgical wounds, their impact on the quality of life of keloid patients, and the need for the most recent data on keloids in Indonesia, this study aims to investigate the characteristics of keloids in surgical wounds in the Department of Reconstructive Plastic Surgery & Aesthetics at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia for the 2019–2022 period. This study provides valuable insights by comparing the characteristics of keloids with previous studies and assessing trends in incidence, risk factors, and treatment outcomes. By expanding on earlier research, this study enhances the understanding of keloid formation in postoperative settings and contributes to improved prevention strategies and more effective management approaches for surgical wound-related keloids.

METHODS

This is a retrospective descriptive study by collecting and processing medical record data of keloid patients due to surgical wounds for the 2019-2022 period. The population used is all keloid patients resulting from surgical wounds at the Outpatient and Inpatient Department of Plastic and Reconstructive Surgery at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia for the period of January 1st, 2019 to December 31st, 2022.

The inclusion criteria for this study are keloid patients resulting from surgical wounds who come and/or are treated at the Outpatient and Inpatient Department of Plastic and Reconstructive Surgery at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia. The exclusion criteria for this study are keloid patients caused by other than surgical wounds. Data obtained from medical records were processed according to the inclusion and exclusion criteria. It was grouped using excel and being analyzed descriptively.

RESULTS

The prevalence of patients who came and/or were treated at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia in 2019-2022 amounted to 2,586,528 patients. Of the 113 patients with abnormal scars, the most cases were keloids, with a total of 58 cases. Followed by hypertrophic scars as many as 51 cases. Additionally, there were 4 cases of combined scar types. The highest number of abnormal scar cases was observed in 2019 (59 cases), while the lowest was in 2021 (15 cases). Over the years, keloids remained the most frequently diagnosed abnormal scar type, with hypertrophic scars following closely behind.

Table 1. Distribution of Abnormal Scar Patients

Abnormal Scars	2019	2020	2021	2022	Total
Keloid	26	15	7	10	58
Hypertrophic Scars	32	7	6	6	51
Combination	1	1	2	0	4
Total	**59**	**23**	**15**	**16**	**113**

Table 2. Distribution of Keloid Causes

Causes	2019	2020	2021	2022	Total
Surgical Wound	8	5	2	8	23
Non-Surgical Wound	18	10	5	2	35
Total	**26**	**15**	**7**	**10**	**58**

Table 2 presents the distribution of keloid cases from 2019 to 2022, totaling 58 cases—23 from surgical wounds and 35 from non-surgical wounds. The highest number of keloid cases due to surgical wounds occurred in 2019 and 2022, with eight cases each, while the lowest was recorded in 2021, with

only two cases. In contrast, keloid cases resulting from non-surgical wounds declined significantly, from 18 cases in 2019 to just two cases in 2022. Overall, keloids caused by non-surgical wounds were more prevalent than those caused by surgical wounds.

Table 3. Distribution of Surgical History

Surgery History	Number of Patients	%
Keloid Excision	12	52.17%
Other Surgery	11	47.83%
Total	**23**	**100%**

Among the 23 patients with keloids due to surgical wounds, 12 (52.17%) had a history of keloid excision, while 11 (47.83%) had a history of other surgeries. This suggests that more than half of the patients had previously undergone keloid excision, highlighting the potential recurrence of keloid formation after surgical removal.

Table 4. Gender Distribution

Gender	Number of Patients	%
Man	10	43.48%
Woman	13	56.52%
Total	**23**	**100%**

Based on Table 4, the distribution of keloid due to surgical wounds was obtained in 10 (43.48%) male patients, and in 13 (56.52%) female patients. This study shows that incidence of keloids due to surgical wounds is dominated by female patients with a ratio of 1.3:1. This finding suggests that women may have a higher predisposition to developing keloids following surgical procedures compared to men.

Table 5. Age Distribution

Age	Number of Patients	%
0-5	1	4.35%
5-11	2	8.70%
12-16	2	8.70%
17-25	7	30.43%
26-35	6	26.09%
36-45	2	8.70%
46-55	1	4.35%
56-65	0	0%
> 65	2	8.70%
Total	**23**	**100%**

The highest incidence of keloids due to surgical wounds was observed in individuals aged 17–25 years, with seven cases (30.43%), followed by those aged 26–35 years, with six cases (26.09%). Meanwhile, no cases of keloids due to surgical wounds were recorded in individuals aged 56–65 years.

Table 6. Occupation Distribution

Occupation	Number of Patients	%
Housewife	1	4.35%
Civil servants	1	4.35%
Student	10	43.48%
Farmers	0	0%
Private Employees	2	8.70%
TNI/Polri	0	0%
Entrepreneur/Self-Employed	1	4.35%
Pensioner	0	0%
Under	2	8.70%
Not working	3	13.04%
Others	3	13.04%
Total	**23**	**100%**

Among the 23 patients with keloids due to surgical wounds, the largest group consisted of students, accounting for 10 cases (43.48%). Meanwhile, private employees (8.70%), unemployed individuals (13.04%), and those in other categories (13.04%) were also represented. No cases were recorded among farmers, military/police personnel, or retirees.

Table 7. Distribution of Family History with Keloid

Family History of Keloid	Number of Patients	%
Yes	1	4.35%
No	3	13.04%
No data	19	82.61%
Total	**23**	**100%**

Of the 23 patients with keloids due to surgical wounds, family history information was not available in the medical records for 19 patients (82.61%). Among the four patients whose family history of keloids was recorded, three (13.04%) had no actual family history of keloids, while one patient (4.35%) had a documented family history of keloids.

Table 8. Distribution of Keloid Locations

Location	Number of Keloids	%
Face	5	12.20%
Ear	10	24.39%
Neck	0	0%
Shoulder	0	0%
Chest	17	41.46%
Back	0	0%
Stomach	0	0%
Upper extremities	7	17.07%
Lower extremities	2	4.88%
Total	**41**	**100%**

There were eight patients who experienced keloid growth due to more than one surgical wound in the same area of the body and also more than one in a different area of the body. In table 8, there are 41 keloids that grow on several parts of the body. The incidence of keloids due to surgical wounds occurred most in the chest area, which was 17 locations (41.46%), followed by the ear area as many as 10 locations (24.29%). Meanwhile keloids due to surgical wounds was not found in the neck, shoulder, and abdominal area.

Table 9. Distribution of Keloid Durations

Duration	Number of Patients	%
< 1 Year	9	39.13%
≥ 1 Year	14	60.87%
Total	**23**	**100%**

In 60.87% cases of surgical wounds, keloids took more than one year to develop, whereas only 39.13% of cases, with a ratio of 1.56:1, developed keloids in less than one year. This indicates that a significant proportion of keloids appear gradually over time, often taking longer than a year to manifest after the surgical procedure.

Table 10. Distribution of Keloid Sizes

Size	Number of Keloids	%
< 20 cm^2	24	58.54%
≥ 20 cm^2	15	36.59%
No data	2	4.88%
Total	**41**	**100%**

In this study, the area of the keloid was measured based on the length and width of the keloid listed on the medical record. Keloids mostly found with a size <20 cm^2 (58.54%), and keloids with a size ≥ 20 cm^2 as many as 15 keloids (36.59%) with a ratio of 1.6:1.

Table 11. Distribution of Keloid Symptoms

Symptom	Number of Symptoms	%
Pain	12	24.49%
Itch	24	48.98%
Contracture	4	8.16%
No symptoms	9	18.37%
Total	**49**	**100%**

There were some patients who experience more than one symptom. The most common symptom found in patients with keloid due to surgical wounds was itching (48.98%), followed by pain (24.49%). The rarest complaint found in patients with keloids due to surgical wounds was contracture (18.37%).

Table 12. Distribution of Therapy Based on Surgical History

Therapy	History		Total	%
	Keloid Surgery	Others		
Surgery	6	4	10	24.39%
Corticosteroid Injection	5	3	8	19.51%
Combination	10	0	10	24.39%
Laser	3	0	3	7.32%
Silicone	0	1	1	2.44%
No data	1	7	9	21.95%
Total	**26**	**15**	**41**	**100%**

Patients with a history of keloid excision most frequently received combination therapy of surgery and corticosteroid injection, with a total of 10 cases (24.39%). Additionally, other therapies administered in this group included surgery alone in 6 cases (14.63%), corticosteroid injection alone in 5 cases (12.20%), and laser therapy in 3 cases (7.32%). Meanwhile, among patients with a history of other surgical procedures, the most common therapy was surgery, performed in 4 cases (9.76%), followed by corticosteroid injection in 3 cases (7.32%)

and silicone application in 1 case (2.44%). A total of 9 patients (21.95%) had no recorded therapy data in their medical records (Table 12).

Patients with keloids measuring less than 20 cm^2 most frequently received combination therapy of surgery and corticosteroid injection, with 7 cases, followed by surgery alone and corticosteroid injection alone, each with 5 cases. Meanwhile, for patients with keloids measuring 20 cm^2 or more, the most common therapies were surgery and corticosteroid injection, each given in 3 cases. Laser therapy was also more frequently administered in this group compared to those with smaller keloids (<20 cm^2), with 3 cases.

Overall, combination therapy of surgery and corticosteroid injection, as well as surgery alone, were the two primary treatment choices for keloids, each applied in 10 cases (24.39%). Corticosteroid injection therapy was administered in 8 cases (19.51%), while laser therapy was used in 3 cases (7.32%), and silicone treatment was applied in only 1 case (2.44%).

A total of 9 patients (21.95%) did not have documented therapy data in their medical records. This data suggests that treatment choices may vary depending on keloid size, with a tendency for combination therapy to be more commonly used for small to moderate-sized keloids, while laser therapy was more frequently applied to larger keloids (Table 13).

Patients with itching symptoms were the most frequently treated group, with a total of 24 cases. Among them, the most commonly used therapy was surgery in 7 cases (20.41%), followed by corticosteroid injection in 5 cases (18.37%), a combination of surgery and corticosteroid injection in 3 cases (20.41%), and laser therapy in 3 cases (12.24%).

Among patients experiencing pain (12 cases), the most common therapy was a combination of surgery and corticosteroid injection in 3 cases (20.41%), followed by laser therapy in 3 cases (12.24%) and corticosteroid injection in 2 cases (18.37%). No patients with pain underwent surgery as a standalone treatment.

Table 13. Distribution of Therapy Based on Keloid Sizes

Therapy	Size (cm^2)			Total	%
	<20 cm^2	≥20 cm^2	No size		
Surgery	5	3	2	10	24.39%
Corticosteroid Injection	5	3	0	8	19.51%
Combination	7	3	0	10	24.39%
Laser	0	3	0	3	7.32%
Silicone	1	0	0	1	2.44%
No caption	6	3	0	9	21.95%
Total	**24**	**15**	**2**	**41**	**100%**

Table 14. Distribution of Therapy Based on Keloid Symptoms

Therapy	Symptoms				Total	%
	Pain	Itch	Contracture	No Symptoms		
Surgery	0	7	3	0	10	20.41%
Cortico-steroid Injection	2	5	1	1	9	18.37%
Combi-nation	3	3	0	4	10	20.41%
Laser	3	3	0	0	6	12.24%
Silicone	0	0	0	1	1	2.04%
No data	4	6	0	3	13	26.53%
Total	**12**	**24**	**4**	**9**	**49**	**100%**

For patients with contracture (4 cases), the primary therapy was surgery in 3 cases (20.41%), while 1 case received corticosteroid injection (18.37%). No patients with contracture underwent combination therapy, laser therapy, or silicone treatment.

Meanwhile, among the 9 patients without keloid symptoms, 4 cases underwent combination therapy (20.41%), 1 case received corticosteroid injection (18.37%), and 1 case underwent silicone therapy (2.04%).

A total of 13 patients (26.53%) had no documented therapy data in medical records, with the highest number found in the group with itching symptoms (6 cases), followed by patients with pain (4 cases) and those without symptoms (3 cases).

DISCUSSION

After conducting a study using the medical record patients in 2019-2022 at the Outpatient and Inpatient Department of Plastic and Reconstructive Surgery at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, 23 cases of keloids caused by surgical wounds were found out of a total of 58 keloid cases. The highest number of cases was recorded in 2019, with 59 patients, followed by a decline in the subsequent years. This downward trend may be attributed to various factors, such as changes in the number of patients seeking treatment, access to healthcare services, or the impact of the COVID-19 pandemic on hospital visits. Non-surgical wounds were more frequently associated with keloid formation than surgical wounds, which may reflect factors such as trauma, burns, or infections as the primary triggers. Additionally, fluctuations in the number of cases from year to year may be influenced by the incidence rate of injuries, wound management methods, or variations in the number of patients seeking treatment. This number tends to increase compared to the previous research conducted at the Department of Reconstructive Plastic Surgery & Aesthetics of Dr. Soetomo General Academic Hospital, in 2014-2017.[9] Another study in Udayana, found as many as 17 cases of keloids that began with a surgical wound.[4] A retrospective study was applied to 125 keloid patients caused by surgical wounds.[13] This indicates that keloids and hypertrophic scars remain a common clinical issue, requiring attention in terms of prevention, diagnosis, and management.

In this study, 12 out of 23 patients with keloids had a history of keloid removal surgery. This indicates that keloid excision does not always prevent recurrence and may even be a risk factor for the formation of new keloids. This underscores the importance of additional preventive approaches, such as adjuvant therapies (corticosteroids, laser, or radiotherapy) after excision to reduce the risk of recurrence. Furthermore, the occurrence of keloids in patients with a history of other surgeries suggests that individual factors, such as genetic predisposition and wound healing processes, also play a role in keloid formation.

There is a difference between keloid excision by general surgeons and plastic surgeons related to surgical strategies, surgical instruments, and wound closure techniques.[14] The choice of excision in keloids can result in larger lesions and even have a recurrence rate of 45-100%.[3] Meanwhile, in this study, 11 patients with keloid due to other surgical wounds, had undergone Coronary Artery Bypass Grafting (CABG) surgery, syndactyl separation, Open Reduction and Internal Fixation (ORIF), Arterial Septal Defect (ASD) closure, and skin grafting. It is known that the tension of the wound after surgery must be properly fixed to prevent the growth of abnormal scars such as keloids. Patients who undergo surgery on certain parts of the body are recommended to be monitored for keloid growth for three to twelve months. Studies show that the use of silicone gel sheets can prevent the formation of keloids in people who are prone to abnormal scarring.[15] Therefore, it is

important for healthcare professionals to monitor the healing process of postoperative wounds and take appropriate measures to prevent excessive scarring.

The incidence of keloids due to surgical wounds obtained in this study was 23 cases, predominantly female patients with a ratio of 1.3:1. It is likely to be related to the number of patients who came and/or were treated at Dr. Soetomo General Academic Hospital, Surabaya, in 2019-2022, predominantly being women (53.93%). In addition, research conducted at Dr. M. Djamil Padang Hospital in 2016-2020 showed that the incidence of keloids was more in women.[16] A study which was conducted in hospitals in India for 18 months, also stated that keloid cases tend to be predominant in women with a ratio of 1.74:1.5 Keloids tend to occur more often in women due to physiological conditions in the female body and social factors where women tend to pay more attention to their appearance and check themselves in the hospital. In addition, this study indicates that females have a higher tendency to develop post-surgical keloids compared to males. This difference may be attributed to hormonal factors, genetics, or variations in wound healing responses between genders. Estrogen, for instance, is suspected to play a role in fibrosis and excessive collagen production, which may increase the risk of keloid formation. Keloids in this study were also found in the ear. It is known that ear injuries due to ear piercings are considered more common in women.[17] These findings underscore the importance of a more optimal preventive approach for female patients undergoing surgical procedures, especially those with a history of keloids.

It was found that keloid cases due to surgical wounds most often occurred at the late adolescence (17-25 years old). Meanwhile, the incidence of keloids due to surgical wounds was not found at the age of 56-65 years. Study in Udayana found that most keloid cases occurred at the age of 19-20 years.[4] Another study found that most of the keloid cases occuent in patients age 22-30 years.[18] This is likely related to the more active skin regeneration and collagen production at this age, which can increase the risk of excessive scar formation. In contrast, in older individuals, the risk of keloid formation is lower due to slower wound healing and decreased collagen production. Keloids occur more often at the age of 20-30 years because there is higher stimulation of sexual hormones, while in older persons, sexual hormones tend to decrease.[19] In addition, excessive sebaceous secretion and elastic skin conditions in adolescents make them prone to keloid formation.[20] These findings highlight the importance of more optimal keloid prevention and management strategies for younger individuals undergoing surgical procedures.

In this study, most of the patients were students. Research conducted at Manado Hospital in 2011-2015, found that most keloid patients were students.[21,22] During puberty, the production of sexual hormones, as in students, leads to rapid and extensive collagen turnover that can trigger keloid formation.[23] Additionally, the lifestyle and activities of this group, such as stress levels, diet, and repeated minor trauma exposure, may also contribute to keloid formation can increase the risk of skin trauma or minor injuries, which develop into keloids in susceptible individuals. Therefore, educating young and active individuals on proper wound care is crucial.

After a study was conducted through medical records at the Outpatient and Inpatient Department of Plastic and Reconstructive Surgery, family history of keloids data Therefore, educating young and active individuals on proper wound care is essential.

Among the four patients whose medical records indicated a family history of keloids, subsequent verification revealed that three did not, in fact, have any relatives with a known history of the condition. This discrepancy highlights potential issues in the

accuracy of patient-reported or recorded familial medical histories. A study conducted at Dr. M. Djamil Central General Hospital, Padang reported that 70.2% of individuals with keloids did not indicate a family history of keloid formation.[16] Similarly, another study observed that the majority of keloid patients lacked familial antecedents of the condition.[22] Despite these findings, several studies suggest that a positive family history is associated with an increased risk of developing keloids. Heritability estimates indicate a rate of 72.41% among first-degree relatives and approximately 17% among second- and third-degree relatives.[11] Individuals with a familial predisposition are not only more likely to develop keloids, but also tend to present with multiple and more severe lesions.

These findings underscore the potential role of genetic factors in keloid pathogenesis, though definitive conclusions remain constrained by data limitations, including inconsistent reporting and a lack of genetic profiling. While heredity appears to contribute significantly, particularly in cases with a strong family history other variables such as wound etiology, anatomical location, and individual healing responses are also critical determinants. Consequently, eliciting a detailed and accurate family history should be an integral component of the preoperative assessment. Patients who report a familial tendency toward keloid formation warrant closer clinical attention and a tailored perioperative management strategy to mitigate the risk of hypertrophic scarring and keloid recurrence.

Certain parts of the body are more susceptible to the occurrence of keloids. The study found that the most common keloid location was the chest (41.46%), followed by the ear (24.39%) and the upper extremities (17.07%). Meanwhile, no keloid cases were found on the neck, shoulders, back, or abdomen.

Increased collagen and a decrease in the number of M1 subtype macrophages are characteristic of skin prone to keloid growth in individuals who have a genetic predisposition.[11] It is found that chest is the common area that developed keloid. It is known that keloids are more common in parts of the body with higher skin tension and are prone to stretching in daily activities, such as the chest. The skin of the chest is extended repetitively by the muscle. This constant repetitive stretching causes the wound to widen and trigger the inflammatory process that may lead development of keloids in the wound.[24] Keloids in the ear are also common. Patients of the female may have predominance sex compared to male patients, becauase ear injuries from procedures like ear piercings are thought to be more common in a woman.[17] Keloids occurring in the ears were mostly found to be caused by surgical removal of previous keloids.

Furthermore, these findings confirm that location influences keloid formation risk, suggesting that prevention and treatment approaches should be tailored to high-risk areas, such as using pressure therapy or optimizing wound care in vulnerable locations.

The duration of growth of keloids is the time from the occurrence of the surgical wound to the appearance of keloids. Keloids can grow as fast as in 1-3 months or take more than 1 year after the occurrence of the injury.[25] The majority of keloids occur three to six months after the onset of the injury.[26] However, in this study, it was found that the mostly duration of growth of keloids due to surgical wounds was more than one year. The study indicates that keloids tend to be chronic and can persist for a long time. Keloids that last more than a year may be more challenging to treat and require a more aggressive therapeutic approach, such as a combination of excision, steroid therapy, laser, or radiotherapy. Research conducted at Djamil Padang Hospital in 2016-2020, shows that mostly keloids did to surgical wound took more than 1 year to develop.[16] Other studies show that the longest duration of growth of keloids is up to two years from the

occurrence of the injury.[27] Additionally, the fact that nearly 40% of cases develop within less than a year highlights that keloids can appear and progress rapidly, making early detection and prompt intervention crucial in preventing further growth.

Knowing the duration of these keloids can help prevent the growth of keloids in the future for optimal monitoring and treatment of postoperative wounds. These findings also emphasize the need for patient education on proper wound care to reduce the risk of persistent keloid formation.

In this study, the size of keloids due to surgical wounds was mostly small to medium sizes. The size of keloids is catagoriesed as: keloids with a size < 20 cm^2 and keloids with a size of ≥ 20cm^2. This indicates that keloids can develop into significant lesions, especially if not properly managed from the outset. The size category used is based on a specific assessment indicator for keloids, namely the JSW Scar Scale (JSS). This scar assessment indicator has been utilized as a standard for assessment abnormal scars in Japan. This scar scale helps to determine the best treatment options for abnormal scars.[15]

The size factor may also influence treatment choices, as larger keloids are often more challenging to treat and more prone to recurrence after procedures such as excision. Therefore, prevention and treatment approaches should be tailored to keloid size to enhance therapeutic effectiveness and reduce the risk of further growth.

Keloids are mostly accompanied by itching. This study shows that itching is the primary complaint among patients with keloids, likely due to the release of inflammatory mediators such as histamine in the excessive wound healing process. Pain is also relatively common, which can affect patient comfort and quality of life.

Elevated TGF-β and histamine in keloids stimulate dermal fibroblasts to produce periostin which can cause itching.[28] Meanwhile, the least complained of symptom in this study is limited movement space or contracture. Although contracture was found in a small percentage of patients (8.16%), this condition can lead to movement limitations if keloids form in joint areas or other mobile body parts. This is related to the theory that contractures are more common in patients with hypertrophic scars than in keloids patient.[29]

The fact that nearly 1 in 5 patients experienced no symptoms is also noteworthy, as it suggests that not all keloids are symptomatic. However, they can still pose aesthetic and psychosocial concerns. Therefore, keloid management should not only focus on treating symptoms but also consider cosmetic factors and the psychological impact on patients.

These data indicate that patients with a history of keloid excision tend to receive combination therapy of surgery and corticosteroid injection as the primary treatment choice (24.39%). This suggests that this combination therapy may be considered more effective in managing post-excision keloids compared to other methods. Meanwhile, for patients with a history of surgeries other than keloid excision, treatment approaches were more varied, with surgery remaining the primary choice (9.76%), followed by corticosteroid injection (7.32%). This may indicate that keloids that develop after other surgical procedures are managed differently compared to those that have already been excised. Additionally, a significant proportion of patients (21.95%) had no therapy data recorded in their medical records, which may reflect a lack of documentation or the possibility that some patients did not receive further treatment after their previous surgical procedure.

In this study, keloids with a size <20 cm^2 were mostly treated using a combination of keloid excision and Corticosteroid injection. Postoperative patients with keloids who undergo combination excision therapy and Corticosteroid injection show a significantly lower recurrence rate in comparison to other treatments such as Corticosteroid injection alone, which has the highest recurrence rate.[13] Keloids with a size of ≥20 cm^2 have

similar frequency of surgical therapy, Corticosteroid injection, combination, and laser. This is not in line with the theory which suggest that large keloids require a more aggressive approach, such as surgery taken after by postoperative radiotherapy.[30] In any cases of keloid, deep discussion with patients is very important, especially in large keloid cases because the main goal of keloid therapy is to improve appearance and reduce the risk of recurrence.

This study indicates that the choice of therapy for keloids varies depending on lesion size. Combination therapy of surgery and corticosteroid injection was the most commonly used treatment, particularly for keloids measuring less than 20 cm^2. This may suggest that this combination is considered more effective in managing smaller or moderate-sized keloids.

For larger keloids (≥20 cm^2), treatment options were more diverse, with surgery, corticosteroid injection, and laser therapy each being applied in 3 cases. The more frequent use of laser therapy in this group may indicate that it is preferred for larger keloids, possibly because this approach is considered more suitable for reducing size and inhibiting keloid growth.

Additionally, 9 patients (21.95%) had no recorded therapy data, which may reflect either the absence of further treatment or a lack of documentation in medical records. Overall, this data suggests that keloid size may influence treatment selection, with a preference for combination therapy of surgery and corticosteroid injection for smaller to moderate-sized keloids, while laser therapy is more commonly used for larger keloids.

Keloids accompanied by itching were most often treated with surgery,as many as 7 cases. Surgical therapy is also the most widely used choice for keloids with complaints of limited space of movement, which is 3 cases. Meanwhile, keloids that are not accompanied by symptoms are most often treated with a combination of surgery and corticosteroid injection.

Keloids accompanied by pain are mostly treated using a keloid excision and followed with injection of Corticosteroid. Keloids accompanied by itching are mostly treated with surgery or Corticosteroid injection.[18] The administration of Corticosteroid injection is known to help relieve pain and itching. In addition, keloids accompanied by limitation of movement are mostly treated with surgery to reduce pressure and discomfort. Study shows that surgical excision of keloids is the main treatment in cases of keloids accompanied with contractures.[3]

Moreover, the choice of therapy for keloids varies depending on the symptoms experienced by the patients. Patients with itching symptoms were more likely to undergo surgery than other treatments, whereas those with pain tended to receive combination therapy or laser treatment. This may suggest that patients with pain require a multifactorial approach to relieve symptoms and inhibit keloid growth.

For patients with contracture, surgery was the primary treatment choice, indicating that this therapy is considered more effective in addressing movement limitations caused by keloids.

Patients without keloid symptoms still received treatment, with a combination of surgery and corticosteroid injection being the primary option. This suggests that therapy is not solely based on subjective symptoms but also on other considerations such as keloid size or location.

Additionally, a substantial proportion of patients (26.53%) had no recorded therapy data, which may reflect a lack of medical documentation or patients who did not undergo further treatment after diagnosis. Overall, this data suggests that the selection of keloid therapy is influenced not only by symptoms but also by other factors affecting treatment effectiveness.

A history of failure on previous keloid therapy may affect the rate of recurrence of keloids. In this study, patients who had a history of keloid surgery were mostly

treated with an excision and followed with injecting Corticosteroid. Surgical excision combined with Corticosteroid injection showed a recurrence rate of 15.4%.[31] Keloids caused by surgeries other than keloid excisions are mostly treated with surgery.

It is known that keloid excision can provide better aesthetic results despite a fairly high recurrence rate. However, to decrease the chance of another keloid formation, the surgeon must ensure a tension free wound closure.[32]

This study has several strengths. It analyzes medical records from 2019 to 2022, covering a substantial number of keloid cases and providing valuable epidemiological insights. The findings highlight that keloid excision alone does not prevent recurrence, emphasizing the need for adjunctive therapies. Additionally, the study identifies trends based on gender, age, and anatomical location, aiding in risk stratification. By evaluating different treatment approaches, including surgery, corticosteroid injections, and laser therapy, it contributes to informed clinical decision-making.

However, this study also has some limitations. As a retrospective study, it is subject to biases such as incomplete documentation and missing patient follow-ups. The analysis includes only 23 cases of keloids resulting from surgical wounds, which may not be fully representative. Although hereditary factors are discussed, no genetic testing was conducted to confirm predisposition. Additionally, the study does not track long-term treatment outcomes, making it difficult to assess recurrence over time. Including a control group without keloid formation would strengthen the study by helping to identify protective factors.

In terms of novelty, the study observes a declining trend in keloid cases, potentially linked to decreased hospital visits during the pandemic. It highlights that the chest is the most common site for keloids and discusses the impact of tension on scar formation. Additionally, it links an increased risk of keloid formation to hormonal activity in adolescents and young adults. The study also provides real-world data showing that combination therapy (excision plus corticosteroid injection) is preferred for smaller keloids, while larger keloids are treated with a more diverse approach, including laser therapy.

This study provides a broad overview of keloid formation in surgical wounds, identifying several risk factors such as age, gender, surgical history, family history, occupation, location, size, and symptoms. It is based on secondary data from medical records, which may result in incomplete or missing information that could affect the overall findings and analysis. The study focuses on keloids arising from surgical wounds, which is crucial for surgical planning and patient management. By examining keloids in surgical wounds, this research offers valuable insights into their prevalence and characteristics, potentially guiding future studies, risk assessment, and management strategies.

CONCLUSION

Based on the results, it can be concluded that keloids due to surgical wounds are most commonly caused by previous keloid surgery. Most keloid patients were female, students, and aged 17–25 years. Keloids were most frequently found on the chest, typically small to medium in size, and often accompanied by itching. This study indicates that keloids are primarily treated with surgery and combination therapy.

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CONFLICT OF INTEREST

The authors pronounced that there is no conflict of interest.

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This study did not get any funding.

AUTHOR CONTRIBUTION

Designed this study and outlined the draft: DYN. Collected information and performed background literature review: DYN. Performed analysis of the statistics: DYN. Supervised results and discussion: DYN, IDS and DMI. Performed grammar and writing checks, critical analysis of the data, manuscript revision, and ensured compliance with publication guidelines: AD, SA and MM. All authors reviewed and approved the final form of the manuscript.

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ASSESSMENT OF MAXILLOFACIAL TRAUMA IN KANJURUHAN GENERAL HOSPITAL MALANG USING FACIAL INJURY SEVERITY SCALE (FISS) SCORING SYSTEM

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ABSTRACT

Introduction: Maxillofacial trauma is a unique form of trauma that may lead to various facial function disabilities. One method to assess the severity of maxillofacial fractures is the Facial Injury Severity Scale (FISS). This study aims to describe and evaluate the severity of maxillofacial trauma cases in the Emergency Room of Kanjuruhan General Hospital Malang using the FISS scoring system, from January 2022 to December 2023.
Methods: This retrospective study collected data from patients with maxillofacial trauma treated at the Emergency Room of Kanjuruhan General Hospital Malang between January 2022 and December 2023. The variables recorded included age, gender, etiology, helmet use, type of fracture, and treatment received. Each patient was evaluated using the FISS scoring system to determine the severity level.
Results: A total of 73 subjects were included. The youngest patient was 2 years old, and the oldest was 76 years. The average FISS score was 3.37 ± 1.9, with scores ranging from 1 to 9. Most patients had a FISS score of 2 (24.7%).
Conclusion: The majority of maxillofacial trauma cases in the Emergency Room of Kanjuruhan General Hospital were classified as mild according to the FISS scoring system. Further studies with a larger sample size and a complete maxillofacial trauma database are needed to evaluate the prognostic value of the FISS system.

Highlights:

1. Most maxillofacial trauma cases were mild, based on FISS scoring.
2. The average FISS score was 3.37, with most patients scoring 2 (24.7%).
3. Larger studies are needed to confirm FISS as a prognostic tool.

INTRODUCTION

Maxillofacial trauma is one of the most common types of trauma found in the emergency department. It is a form of physical trauma that affects both the hard and soft tissues of the face.[1,2] The causes of maxillofacial trauma are varied, including traffic accidents, physical abuse, falls, sports injuries, and gunshot wounds.

Traffic accidents remain a major concern, causing 1.35 million fatalities annually and being the leading cause of death among children and young adults.[3,4] Traffic accidents also have the highest percentage of disability and death in adults, particularly those under the age of 50, with the greatest prevalence usually affecting individuals aged 21-30 years.[2,5] In Indonesia, after a decline in 2020, traffic accidents increased again in 2021.[4-6] According to reports, between January 2015 and September 2019, there were 3,736 traffic accidents, and 20% (930 people) of these resulted in fatalities.[7,8]

Traffic accident data plays a crucial role in identifying high-risk areas and contributing factors, forming the basis for traffic safety interventions. However, research interest in utilizing this data remains low, with limited national-scale studies. While police-documented accident data is publicly accessible, optimizing traffic survey data, such as the Indonesian Family Life Survey (IFLS), could enhance research accuracy. Integrating self-reported accident data with official records may improve validity, though challenges like reporting biases must be addressed.[9-12]

Traffic accidents, especially those involving motorcycles, are generally caused by driver error, lack of road safety training, inadequate vehicle maintenance, poor road conditions, failure to wear seatbelts or helmets, driving under the influence of drugs or alcohol, and disobeying traffic rules. However, these statistics are not followed by careful road users. Factors such as age, economic status, and educational background influence their safety awareness. Among these, driver negligence is the leading cause of head and facial injuries, including craniofacial trauma.[13-16]

Traffic accidents can cause various types of injuries, such as head and neck injuries, chest injuries, abdominal and pelvic injuries, and extremity injuries. Head trauma is the leading cause of death and the most common injury resulting from traffic accidents involving two- or three-wheeled motor vehicles.[17-18] At Kanjuruhan General Hospital Malang, maxillary fractures were the most common maxillofacial fractures, accounting for 42% of total cases, followed by mandible fractures (23%) and zygomatic fractures (15%). About 37% of patients were referred for treatment to other hospitals with plastic surgeons, as Kanjuruhan General Hospital Malang does not have a plastic surgeon.[7,8]

A scoring system has been in use since the 1970s to measure the severity level in trauma patients. The aim is to identify the prognostic value of trauma, making it a useful tool in research. Initially, most scoring systems only evaluated general trauma, such as the Injury Severity Score (ISS), Traumatic and Injury Severity Score (TRISS), and New Injury Severity Score (NISS).[19] Facial trauma requires a different scoring system because of the many functional impairments it can cause. Several journals have reported the existence of scoring systems for maxillofacial trauma, such as the Facial Injury Severity Scale (FISS) and Mandible Injury Severity Score (MISS). The Facial Injury Severity Scale (FISS) is a simple and easy-to-use scoring system for assessing the severity of maxillofacial trauma. This method describes maxillofacial injuries based on facial anatomical involvement.[20,21]

Although these scoring systems have been introduced in many journals, they are not yet widely used by clinicians due to a lack of awareness of their benefits. In many clinical settings, the assessment of facial injuries still relies on subjective evaluation without a standardized method to quantify severity. As a result, important aspects such as documentation consistency, outcome prediction, and communication among

multidisciplinary teams may be compromised. Implementing standardized scoring systems like FISS could help streamline trauma evaluation and improve patient management.

This study aims to describe and evaluate the severity of maxillofacial trauma cases treated in the Emergency Room (ER) of Kanjuruhan General Hospital Malang using the Facial Injury Severity Scale (FISS), covering the period from January 2022 to December 2023. Specifically, it seeks to identify the distribution of trauma severity based on FISS scores and assess the potential of FISS as a tool for clinical documentation, prognosis assessment, and research. By providing an evidence-based approach to implementing the FISS scoring system in clinical practice, this study is expected to enhance trauma care protocols and facilitate better management of maxillofacial injuries. As the first local research in the Malang region to apply FISS in a clinical setting, the findings may also serve as a foundation for further studies and encourage broader application of FISS across other regions in Indonesia and beyond.

Despite the high frequency of maxillofacial trauma, particularly from traffic accidents, there is limited research on the application of specialized trauma severity scoring systems, such as the FISS, in clinical settings. Current trauma scoring systems, like the Injury Severity Score (ISS), do not address the unique characteristics and functional impairments caused by facial injuries. This knowledge gap in clinical practice is further exacerbated by the limited awareness and utilization of the FISS scoring system, which could aid in predicting outcomes and improving treatment protocols for maxillofacial trauma.

While various trauma scoring systems, such as the ISS, TRISS, and NISS, have been introduced in the literature, there is limited research on the application of FISS specifically for maxillofacial trauma. This knowledge gap is particularly evident in Indonesia, where no local studies have applied FISS to evaluate maxillofacial trauma in a clinical setting. The novelty of this study lies in being the first local research to apply FISS in the evaluation of maxillofacial trauma at Kanjuruhan General Hospital Malang, which can serve as a model for similar healthcare settings in semi-urban regions of Indonesia.

With the FISS, this study not only validates the specificity of maxillofacial trauma severity but also measures its validity in terms of the extent of clinical intervention required and duration of care in the patient. The data gathered are meant to provide the empirical foundation upon which diagnostic accuracy can be improved, treatment can be ordered, and hospital resources can be utilized effectively. In addition, the result of this study can serve as a point of reference in the development of more locally relevant evidence-based clinical guidelines. Also, application of FISS would be able to improve the medical staff's sensitivity to the requirement for standardized evaluation in facial trauma patients. Hence, this research presents a strategic contribution to improving the documentation, assessment, and management system of maxillofacial trauma cases in Indonesia.

METHODS

This study employed a descriptive retrospective design to evaluate the application of the Facial Injury Severity Scale (FISS) in patients presenting with maxillofacial trauma. Medical records of all patients treated for maxillofacial injuries in the Emergency Room of Kanjuruhan General Hospital Malang between January 2022 and December 2023 were reviewed. Cases were identified retrospectively using ICD-10 diagnostic codes. Extracted data encompassed both demographic variables (including age, sex, and name) and clinical characteristics (such as etiology of trauma, helmet usage, fracture type, and the administered treatment). Each case was subsequently assessed using the FISS scoring

system to objectively determine the severity of the facial injury.

This scoring system provides a way to objectively quantify the severity of maxillofacial injuries, helping clinicians in both research and clinical settings to assess trauma and predict prognosis more accurately. The detailed breakdown ensures that various facial injuries, from simple fractures to complex, multi-fracture cases, are appropriately categorized, facilitating better decision-making and treatment planning.The FISS scoring system categorizes injuries based on facial anatomical involvement and provides a quantifiable way to assess trauma severity. Below is a detailed specification of the trauma categories and associated points (Table 1).

Table 1. The Specification in FISS Score.[22]

Trauma Specifications	Points
Mandible:	
Dentoalveolar	1 point
Fracture On Corpus/Ramus/ Symphisis	2 points
Fracture On Condyle/ Coronoid	1 point
Mid-Facial: (Each Facial Fracture Was Give 1 Point, Except For Complex Fracture)	
Dentoalveolar	1 point
Le Fort I	2 points
Le Fort II	4 points
Le Fort III (Unilateral Le Fort Was Given Half The Point)	6 points
Naso-Orbital Ethmoid (NOE)	3 points
Zygomatico Maxillary Complex	1 point
Nasal	1 point
Upper Third Facial	
Roof/ Wall of Orbital	1 point
Fracture Os/Sinus Frontal Displaced	5 points
Fracture Os/ Sinus Frontal Nondisplaced	1 point
Facial Laseration Over 10cm	1 point

RESULTS

Based on medical record data from the Emergency Room of Kanjuruhan General Hospital Malang between January 2022 and December 2023, a total of 73 patients were diagnosed with maxillofacial trauma.

These patients were evaluated across various demographic and clinical factors to better understand the patterns and characteristics of maxillofacial injuries in this setting. The following table 2 provides a detailed distribution of patients by sex, age, cause of trauma, helmet use, and treatment provided, offering insights into the primary factors contributing to these injuries and the initial management approaches.

Table 2. Distribution of Patients by Sex, Age, Cause of Trauma, Helmet Use, and Treatment

Variable	Frequency (%)
Sex	
Male	63.01
Female	36.99
Age (year)	
2-11	17.81
12-25	46.58
26-45	24.66
>46	10.96
Cause of Trauma	
Traffic accident	50.68
Work accident	20.55
Falling from a height	19.18
Interpersonal violence	6.85
Sport accident	2.74
Helmet Use	
Wearing a helmet	63.01
Not wearing a helmet	36.99
Treatment	
Reffered for treatment	36.99
Refused treatment	27.40
Conservative treatment	19.18
Surgery without plate	16.44

The average age of the patients was 32.5 ± 11.5 years, with the youngest being 2 years old and the oldest 76 years old. Of the 73 patients, 46 (63%) were male and 27 (37%) were female. The most common cause of maxillofacial trauma was traffic accidents (50.68%), followed by work-related injuries (20.55%), falls from height (19.18%), interpersonal violence (6.85%), and sports injuries (2.74%). More than half of the patients involved in traffic accidents were not wearing helmets (63.01%).

Regarding treatment, 27 patients (36.99%) were referred to other hospitals due to the need for reconstructive surgery

with plates and screws, which could not be performed at our facility due to the absence of a plastic surgeon. Twenty patients (27.40%) refused treatment, 14 patients (19.18%) received conservative management, and 12 patients (16.44%) underwent surgery without plates and screws (e.g., debridement and suturing).

To evaluate the severity of maxillofacial trauma among patients treated in the Emergency Room, each case was assessed using the Facial Injury Severity Scale (FISS). The distribution of FISS scores recorded between January 2022 and December 2023 is presented in the table below. This scoring system provides an objective measure of facial injury severity and serves as a valuable tool for prognosis estimation, treatment planning, and research in the field of maxillofacial trauma management.

Table 3. Fiss Score Of Maxillofacial Trauma Patients in January 2022 - December 2023

FISS score	Number of Patients	Percentage (%)
1	14	19.18
2	21	28.77
3	8	10.96
4	9	12.33
5	11	15.07
6	4	5.48
7	4	5.48
8	1	1.37
9	1	1.37
Total	**73**	**100**

Using the Facial Injury Severity Scale (FISS), the average score was 3.42 ± 1.9, with a minimum score of 1 and a maximum score of 10. The most common FISS scores were 2 (28.77%) and 5 (15.07%).

Table 4 shows the distribution of maxillofacial trauma severity among patients based on their Facial Injury Severity Scale (FISS) scores. The severity is categorized into three groups: mild, moderate, and severe, according to the score ranges.

Table 4. Distribution of Severity

Severity	Frequency	Percentage (%)
Mild *(FISS Score 1-3)*	43	58.9
Moderate *(FISS Score 4-7)*	28	38.36
Severe *(FISS Score 8-15)*	2	2.74
Total	**73**	**100**

The majority of the patients (58.9%) were classified as having mild trauma, with FISS scores ranging from 1 to 3. This indicates that most cases involved less severe injuries, potentially involving fractures that did not cause significant functional impairment. A significant portion of patients (38.36%) had moderate trauma, with FISS scores ranging from 4 to 7, suggesting a higher level of injury requiring more intensive treatment. Only a small fraction of patients (2.74%) experienced severe trauma, with FISS scores between 8 and 15, highlighting the relatively low frequency of highly severe facial injuries among the study population. This distribution is important for understanding the overall burden of maxillofacial trauma and guiding appropriate resource allocation for patient care in the emergency department.

DISCUSSION

In this study, which included 73 patients diagnosed with maxillofacial trauma, the majority were young adults, with a marked male predominance approximately six times higher than the number of female patients. Traffic accidents emerged as the primary etiology, responsible for more than half of the cases. Notably, a substantial proportion of individuals involved in these incidents were not wearing helmets at the time of injury, underscoring a critical deficiency in adherence to traffic safety regulations, particularly among motorcyclists.

Due to the complexity of certain injuries, many patients required surgical intervention using plate and screw fixation to stabilize facial fractures. However, because Kanjuruhan General Hospital does not have an on-site plastic or maxillofacial surgeon, these patients were referred to tertiary care centers capable of performing reconstructive surgery. Meanwhile, patients with less severe injuries or without functional impairments were managed conservatively with non-operative treatment, such as wound debridement and suturing.

The Facial Injury Severity Scale (FISS) was utilized in this study as an objective tool to quantify the severity of facial trauma. FISS is recognized for its simplicity, reliability, and applicability in emergency settings. It enables rapid assessment and facilitates standardized communication among healthcare providers, including surgeons, emergency physicians, and trauma teams. The tool has been validated in various clinical environments and supports the coordination of multidisciplinary care in facial trauma management.[23-26]

We used the Facial Injury Severity Scale (FISS) to evaluate the severity of maxillofacial trauma because it is a simple scoring system, and the data required for its calculation were readily available from medical records. However, the FISS does not include functional disabilities as one of its determining variables.

According to a study by Bagheri et al. published in 2006, a higher FISS score was associated with increased treatment costs, but there was no clear association between the FISS score and the need for specialized surgical intervention, suggesting that a threshold score may exist for such procedures.[22] Moreover, a study conducted at Dr. Soetomo General Hospital in Surabaya utilized FISS retrospectively with existing medical records and radiological imaging. The researchers determined that FISS could predict hospital stay duration effectively, demonstrating its usability and convenience in clinical practice.[27] Similarly, a study at Sanglah General Hospital in Denpasar applied FISS to grade maxillofacial fracture severity. The study determined that FISS scores had predictive value for length of stay in patients and validated the scale as an easy, widely available method of facial trauma assessment.[28] These studies collectively support that FISS is a simple-to-use system, with data readily obtained from routine medical records, thus making it simple to implement into regular clinical practice for assessment of maxillofacial trauma severity.

In this study, the average FISS score was 3.42, with the most common score being 2, and only one patient recorded a score of 10. These findings indicate that the majority of maxillofacial trauma cases involved relatively minor injuries. In a previous study, Bagheri et al. reported an average FISS score of 4.4, with a maximum score of 13. The differences in score distribution between our study and theirs may be attributed to the higher-velocity trauma observed in Bagheri's study, which resulted in more severe injuries. In contrast, trauma cases in Malang are predominantly low-velocity, often associated with poor compliance with traffic regulations.

This study contributes meaningful epidemiological evidence on maxillofacial trauma within the Malang region of Indonesia, offering data that can guide the refinement of clinical management protocols and inform the development of targeted prevention strategies. The utilization of the Facial Injury Severity Scale (FISS) facilitated a standardized and objective appraisal of injury severity, enhancing the comparability of findings across studies and supporting the establishment of uniform assessment methodologies. Additionally, the results underscore the pivotal role of helmet use in mitigating injury severity, thereby underscoring the necessity for comprehensive public education initiatives and the stringent enforcement of existing traffic safety legislation.

However, several limitations should be acknowledged. The retrospective nature of the study means it relies on medical records,

which may be incomplete or inconsistent. Additionally, the relatively small sample size limits the generalizability of the results. The absence of long-term follow-up data also restricts the ability to evaluate functional and aesthetic outcomes across different treatment modalities.

Despite these limitations, this study offers novel contributions as the first in Malang, Indonesia, to evaluate maxillofacial trauma using the FISS scoring system. It enhances regional understanding of trauma patterns and highlights the challenges faced by local healthcare facilities in managing complex facial fractures, particularly the need for better-equipped hospitals. Moreover, the findings support the critical role of traffic law enforcement in reducing both the incidence and severity of maxillofacial trauma, providing important evidence for public health policy and intervention.

CONCLUSION

The distribution of Facial Injury Severity Scale (FISS) scores in this study indicates that the majority of maxillofacial trauma cases presenting to the Emergency Room of Kanjuruhan General Hospital Malang between January 2022 and December 2023 were classified as mild (FISS scores 1–3). This pattern is likely attributable to the predominance of low-velocity motorcycle collisions, compounded by suboptimal adherence to traffic safety regulations. These findings are reflective of regional trauma trends and may have broader applicability to comparable semi-urban settings across Indonesia. To further elucidate the prognostic utility of the FISS and to inform enhancements in trauma management protocols, future research should incorporate larger, multicenter cohorts and longitudinal outcome assessments.

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CONFLICT OF INTEREST

The authors declare no conflict of interest in this study.

FUNDING DISCLOSURE

The authors declare that no funding was received for this study.

AUTHOR CONTRIBUTION

KKMP contributed to data collection, data analysis, interpretation of the results, manuscript preparation, and revisions. DSN contributed to data collection, data analysis, interpretation of the results, and validation.

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CHRONIC WOUNDS : RISK FACTORS AND EVIDENCE-BASED INTERVENTION

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ABSTRACT

Introduction: Chronic wounds are a pervasive and escalating public health issue, characterized by their inability to progress through the typical phases of healing, resulting in prolonged tissue damage and patient morbidity. Common types include diabetic, pressure, arterial, and venous ulcers. Factors like comorbidities, infection, poor circulation, and inadequate care delay healing. This review aims to explore the risk factors for chronic wounds and evaluate evidence-based interventions to optimize treatment outcomes, thereby improving patient care and reducing healthcare costs.
Methods: A thorough literature review was performed using peer-reviewed journals and reliable medical databases, focusing on articles from the past 10 years for relevance. The search used keywords like "chronic wounds," "risk factors," "management," and "evidence-based interventions," selecting studies that addressed the epidemiology, causes, and treatment of chronic wounds.
Results: The review identified major risk factors for chronic wounds, such as diabetes, poor circulation, neuropathy, infection, and aging. Effective treatments discussed include advanced dressings, debridement, negative pressure wound therapy, and skin grafts. A multidisciplinary, patient-focused approach was found to improve healing outcomes.
Conclusion: Understanding the risk factors of chronic wounds and applying evidence-based, personalized treatments can significantly improve healing outcomes. Ongoing research and innovation are essential to address gaps in care and enhance patient management.

Highlights:

1. Identifies key risk factors for chronic wounds and the underexplored role of genetics and immune dysregulation in healing.
2. Explores advanced interventions like smart bandages and bioengineered skin, while addressing accessibility challenges.
3. Highlights the potential of personalized medicine and digital health in improving patient-centered wound care.

INTRODUCTION

Chronic wounds are a pervasive and escalating public health issue, defined by their inability to proceed through the typical phases of healing, leading to prolonged tissue damage and patient morbidity.[1] Chronic wounds are associated with significant morbidity, a profound decline in quality of life, and considerable economic and societal burden, globally.[2] Conditions such as diabetic foot ulcers, venous ulcers, and pressure ulcers are among the most common types, with diabetes and vascular diseases identified as primary risk factors.[3-5] These wounds not only diminish the quality of life for affected individuals but also impose an enormous financial burden, with billions spent annually on wound management and related complications.[4,5]

The global prevalence of chronic wounds continues to rise, affecting approximately 1-2% of the population in developed countries.[6] In the United States alone, around 8.2 million Medicare beneficiaries suffer from chronic wounds, contributing to an annual cost estimated between $28.1 billion and $31.[7] billion.[8] Similarly, in Europe, the economic burden is substantial, with wound care expenses accounting for 2-4% of total healthcare costs.[8] Diabetic foot ulcers (DFUs), one of the most common chronic wound types, affect 6.3% of individuals with diabetes worldwide, translating to an estimated 33 million people globally.[9] These figures underscore the urgent need for improved wound management strategies to alleviate the clinical and financial burden on healthcare systems.

The pathophysiology of chronic wounds is multifaceted, involving prolonged inflammation, impaired angiogenesis, and delayed epithelialization.[7] Key contributors include poor blood circulation, neuropathy, and infections,which significantly disrupt the tightly regulated healing process.[3,8] The pathophysiology of chronic wounds involves disruptions in the classical healing pathway, including hemostasis, inflammation, cellular proliferation, and remodeling, leading to prolonged or impaired wound healing.[10] Emerging evidence also highlights the role of genetic factors and immune dysregulation, such as altered expression of key proteins like FOXM1, which are critical for the recruitment of immune cells necessary for tissue repair. [7,8]

Despite advancements in healthcare, a significant gap persists in effective treatment options for chronic wounds.[3] Standard approaches, including debridement and conventional dressings, often fail to address the underlying mechanisms of delayed healing.[4,7] Despite promising clinical results, therapies such as biomaterials and smart bandages remain underutilized. This underuse can be attributed to limited cost-effectiveness studies and regulatory barriers, which hinder widespread adoption. Consequently, addressing gaps in wound care practices and restricted access to specialty care further exacerbate these challenges, especially in low-resource settings.[6,8] This review seeks to analyze the multifactorial risk factors contributing to chronic wounds and evaluate contemporary, evidence-based interventions aimed at improving healing outcomes.[1,3] By addressing gaps in current knowledge, this review highlights the potential for multidisciplinary and innovative approaches to transform chronic wound care.[8] The findings are intended to support clinicians in optimizing therapeutic strategies and guiding future research for more effective interventions.[4,7]

METHODS

A comprehensive literature review was conducted to explore the risk factors and evidence-based interventions for chronic wounds through a systematic search of literature using Google Scholar, a widely used platform for accessing scholarly articles, journals, and books. The search employed thematic keywords such as “chronic wounds, risk factors, interventions,” along with targeted phrases

like "management of diabetic ulcers," "treatment for pressure ulcers," and "techniques in skin grafting" to gather comprehensive and specific insights. Publications from 2014 to 2024 were included to ensure relevance to current practices. The search produced a variety of sources, ranging from general overviews to focused studies on individual aspects of chronic wound care. By analyzing and synthesizing these studies, this review aims to present a thorough understanding of the risk factors and modern therapeutic approaches for chronic wounds. Figure 1 below shows the PRISMA flowchart.

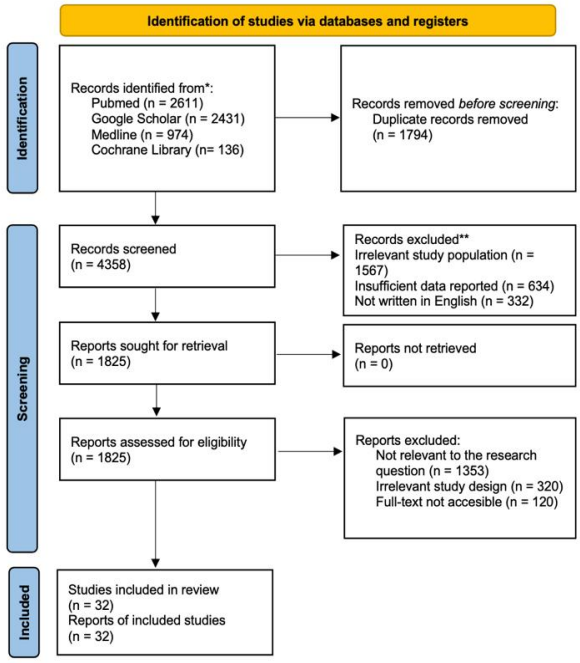

Figure 1. PRISMA Flowchart in This Study

RESULTS

The systematic search conducted across multiple databases, including Medline, Embase, CINAHL, and the Cochrane Library, resulted in a total of 6,152 articles on chronic wound risk factors and evidence-based interventions. Of these, 4,358 articles were published between 2014 and 2024, aligning with the review's criteria. After screening for relevance and removing duplicates, 1,825 articles were further reviewed based on their titles and abstracts. A total of 112 full-text articles were assessed for eligibility.

Ultimately, 32 articles were selected for inclusion in this literature review based on the predefined criteria, including studies on diabetic foot ulcers, pressure ulcers, and venous ulcers. These studies focused on a variety of interventions, such as advanced dressings, negative pressure wound therapy, and skin grafting, as well as key risk factors like diabetes, poor circulation, neuropathy, infection, and aging. Additionally, some studies explored the role of genetic factors and immune dysregulation in wound healing, particularly the impact of proteins like FOXM1 on immune cell recruitment.

The included studies were conducted in various countries, including the United States, the United Kingdom, Australia, and several European nations. The findings from these studies revealed that the most effective interventions for chronic wounds included advanced wound dressings like silver-based dressings and sucrose octasulfate, negative pressure wound therapy, and surgical approaches, such as skin grafting. However, challenges in accessibility and high costs limited the widespread use of some of these treatments, particularly in low-resource settings.

The synthesis of the results suggests that a combination of clinical interventions, patient education, and multidisciplinary care approaches significantly improves chronic wound healing outcomes. Furthermore, the review emphasizes the need for further research into the genetic and immunological factors that contribute to chronic wound development.

DISCUSSION

Risk Factors in Chronic Wound Development

The complexity of the wound healing process makes wounds susceptible to many levels of disruption due to many factors. The most common risk factors identified in the

literature include diabetes, poor circulation, neuropathy, infection, and aging.[9,11] Among these, diabetes mellitus is one of the primary contributors to delayed wound healing. Diabetic foot ulcers are particularly difficult to treat due to impaired immune function and poor blood flow associated with the disease.[12] The elevated blood glucose levels in diabetic patients inhibit the normal inflammatory response necessary for healing, which can delay wound closure and lead to complications such as infections or amputations.[9,13]

In addition to diabetes, vascular insufficiency plays a crucial role in the development of chronic wounds. Impaired blood circulation reduces the delivery of oxygen and nutrients to the affected area, which is essential for tissue repair. Vascular disease is particularly relevant in conditions like venous leg ulcers, where poor venous return causes blood to pool in the lower extremities, further impeding wound healing.[11,12] This impaired venous function occurs because in patients with obesity, intra-abdominal pressure increases, leading to increased reflux, as well as venous diameter and pressure.[14]

Another significant risk factor is neuropathy, which is most common in patients with diabetes but can also occur due to other conditions such as alcoholism and chronic kidney disease. Neuropathy leads to a loss of sensation in the affected areas, which prevents individuals from detecting early signs of wounds, such as cuts or blisters, resulting in untreated injuries that may develop into chronic wounds.[9] Neuropeptides such as nerve growth factor, substance P, and calcitonin gene-related peptide are relevant for wound healing because they cause cell chemotaxis, induce growth factor production, and stimulate cell proliferation.[15]

Infection plays a critical role in the development and persistence of chronic wounds. often delaying healing by prolonging inflammation and disrupting tissue repair. Microorganisms like *Staphylococcus aureus* and *Pseudomonas aeruginosa* commonly form biofilms, which resist antibiotics and immune defenses, leading to persistent inflammation and tissue damage.[16] Chronic wound infections can escalate to systemic complications, especially in immunocompromised patients or those with diabetes.[17]

Approximately 1% to 2% of the population over 60 years of age in developing countries experience chronic wounds during their lifetime.[18] In older people, there are many changes in both physiological and neurological functions in the body that decline and make it difficult for wounds to heal. Younger skin is able to regulate the response to change by producing ECM that adapts to mechanical injury, while older skin atrophies and has a prolonged healing response that often results in inflammation and delays in signal transduction resulting in a lack of ECM production. In addition, in old age there is a decline in the circulatory system which inhibits the wound from achieving angiogenic repair. [19]

Current Evidence-Based Interventions

A significant body of research has focused on identifying evidence-based interventions to improve chronic wound healing. Among the most effective interventions are advanced wound dressings, negative pressure wound therapy (NPWT), and surgical techniques such as skin grafting.[20-22] Advanced dressings, including silver-based dressings, sucrose octasulfate, and hydrocolloids, are designed to provide an optimal wound environment by maintaining moisture, reducing infection, and promoting tissue growth.[20] These dressings have been found to significantly enhance healing rates, particularly for diabetic and venous ulcers, by preventing bacterial colonization and providing a barrier against external contaminants.[21]

Negative pressure wound therapy (NPWT) has also been shown to be effective in managing chronic wounds. NPWT works

by applying controlled negative pressure to the wound, which accelerates healing by improving blood flow, reducing edema, and promoting the formation of granulation tissue.[21] Despite its efficacy, the high cost of NPWT devices and the need for skilled application limit their widespread use, particularly in resource-limited settings.[22]

Skin grafting, often used for larger or deeper wounds, remains a critical surgical intervention. It involves transplanting healthy skin from another area of the body to cover the wound. Recent advancements in grafting techniques, including the use of bioengineered skin, have further improved the success rates of this procedure.[21] However, the challenge remains in ensuring that patients have access to these treatments, which may not be available in all healthcare settings.[22]

Furthermore, innovations such as spray-on skin cells, 3D-printed skin constructs, and stem-cell-enhanced grafts are being explored to enhance healing outcomes and minimize donor site morbidity. These techniques have the potential to accelerate recovery, reduce scarring, and improve the overall functionality of grafted skin. However, factors such as cost, regulatory approval, and the need for specialized equipment limit widespread adoption.

In addition, patient-specific factors, including age, comorbidities such as diabetes or vascular disease, and nutritional status, play a crucial role in graft survival and integration. Optimizing preoperative care, ensuring adequate post-operative wound management, and incorporating multidisciplinary approaches can significantly enhance the effectiveness of skin grafting procedures.

A comparative analysis of different wound therapies reveals significant variations in effectiveness, healing time, and cost. Table 1 summarizes these findings, highlighting key differences between NPWT, advanced dressings, and skin grafting.

Table 1. Comparison of Effectiveness between Wound Therapy Methods

	NPWT	**Advanced Dressings**	**Skin Grafting**
Healing Rate Improvement	40-60% faster healing than standard care[1]	30-50% improvement in wound healing[6]	70-90% wound closure success for full-thickness wounds[11]
Time to Wound Closure	4-6 weeks for moderate wounds[2]	6-8 weeks for moderate wounds[7]	3-6 weeks for full healing[12]
Cost Effectiveness	High initial cost but cost-effective in long-term care[4]	Lower cost, widely accessible[9]	Expensive and requires surgical expertise [14]

NPWT is ideal for accelerating healing in complex wounds despite its higher initial cost. Advanced dressings offer a balance of affordability and effectiveness, suitable for less severe wounds. Skin grafting provides the highest success rates but is resource-intensive, making it best suited for severe wounds requiring complete tissue restoration.

Barriers to Effective Chronic Wound Management

Effective management of chronic wounds is often hindered by various barriers. One key challenge is the lack of adequate knowledge and training among healthcare providers, which can lead to suboptimal care. Many professionals report insufficient wound care education, contributing to delayed healing and complications.[23] Additionally, resource constraints, such as limited access to specialized products and equipment, particularly in rural or low-income areas, exacerbate treatment challenges.[24] Patient-

related factors, including non-compliance with treatment and underlying comorbidities like diabetes, further complicate wound healing, as these conditions impair circulation and immune function.[25] Delayed diagnosis and referral to wound care specialists also contribute to poor outcomes, with many patients presenting too late for effective intervention.[26] Financial barriers, such as the high cost of care and inadequate insurance coverage, can prevent patients from adhering to prescribed therapies.[27] Finally, psychosocial and cultural factors, including mental health issues and stigma, discourage patients from seeking care or following through with treatment plans.[28,29] Overcoming these barriers is essential for improving chronic wound management and ensuring better patient outcomes.

Future Directions in Chronic Wound Research

Looking ahead, several promising areas of research could transform the management of chronic wounds. One such area is the development of "smart" wound care technologies, such as bioengineered skin and intelligent bandages that can monitor wound conditions and release therapeutic agents in real-time. These advancements could greatly enhance wound healing by providing continuous monitoring and targeted treatment.[30] Moreover, advancements in diagnostic tools, such as imaging technologies and biomarkers, could enable earlier detection of chronic wounds and more precise monitoring of healing progress, facilitating timely interventions.[31]

Another exciting direction is the use of stem cell therapy and regenerative medicine to promote wound healing. Stem cells have the potential to accelerate tissue regeneration by stimulating the growth of new blood vessels, skin cells, and other tissue components essential for wound healing.[22,25] Although this field is still in its early stages, ongoing studies are exploring the use of stem cells to treat hard-to-heal chronic wounds, with early results showing promising outcomes.[18]

Furthermore, personalized medicine approaches, which take into account individual genetic profiles and wound characteristics, could significantly improve chronic wound care by tailoring treatments to the specific needs of each patient.[20,21]

The integration of digital health technologies, such as telemedicine and wound care apps, is also an exciting area for research. These technologies can enhance remote monitoring and provide better access to specialist care, particularly in underserved.[32]

Despite promising clinical results, innovative therapies such as biomaterials and smart bandages remain underutilized due to limited cost-effectiveness studies and regulatory barriers.[33-35] The lack of long-term economic evaluations makes it difficult for healthcare providers and policymakers to justify the high initial costs of these technologies.[36] Furthermore, regulatory approval processes for novel wound care products vary across regions, creating additional obstacles to widespread adoption. Addressing these gaps through robust health economic research and streamlined regulatory frameworks is essential to facilitate the integration of innovative wound therapies into standard clinical practice.

Understanding the role of the microbiome in wound healing is another emerging area. The gut and wound microbiomes play a significant role in inflammatory processes, and future research may focus on how modifying these microbiomes can improve healing outcomes.[28]

Lastly, development of health policy strategies to increase access to chronic wound care as one of the most urgent research areas in chronic wound management. Despite advancements in treatment, many patients—especially those in low-resource settings—face significant barriers to receiving timely and appropriate

wound care. Limited availability of specialized wound care centers, high treatment costs, and disparities in insurance coverage contribute to delayed interventions and poor outcomes. Current research should focus on identifying cost-effective healthcare models, such as integrating chronic wound care into primary healthcare services and expanding telemedicine programs for remote monitoring. By integrating chronic wound management protocols into primary healthcare settings, physicians can identify high-risk patients earlier and initiate timely interventions, reducing complications. By addressing systemic gaps through targeted policies, the burden of chronic wounds on healthcare systems could be significantly reduced, improving patient quality of life and decreasing overall healthcare expenditures.

Managing chronic wound infections requires a multidisciplinary approach. Differentiating between infected and uninfected chronic wounds can be challenging, and routine wound culturing is not always appropriate. Debridement is essential to facilitate the healing process. Additionally, proper wound bed preparation and antisepsis must be combined to prevent delayed healing and complications. Systemic antibiotics should be used judiciously, as inappropriate use can lead to multidrug resistance and adverse effects. Therefore, an expert multidisciplinary team is crucial for optimal chronic wound infection management.[37]

This review offers significant strengths, including a synthesis of high-quality evidence from diverse sources and ensuring a comprehensive understanding of chronic wound management. It examines both well-established interventions and emerging innovations, like bioengineered skin and smart bandages, while addressing the role of multidisciplinary, patient-centered care in improving outcomes. The inclusion of global perspectives further strengthens the study by considering variations in healthcare systems and accessibility to advanced chronic wound treatments.

However, this review has several limitations. First, the reliance on secondary data introduces the risk of publication bias, as studies with negative or inconclusive results may be underrepresented. This could lead to an overestimation of the effectiveness of certain interventions. Second, while the review integrates findings from various healthcare settings, its applicability to low-resource environments remains limited due to differences in infrastructure, availability of advanced wound care products, and trained healthcare personnel. Future research should address these disparities by evaluating cost-effective and scalable interventions suitable for diverse socioeconomic contexts.

From a clinical perspective, these limitations highlight the need for further real-world studies that assess the long-term efficacy of novel interventions in different patient populations. Additionally, the findings underscore the necessity of developing standardized treatment protocols that consider genetic and immune-related factors contributing to chronic wounds. On a policy level, this review advocates for increased investment in research and healthcare infrastructure to improve access to innovative wound care solutions, ensuring that transformative technologies are both affordable and widely implemented.

The novelty of this review lies in its exploration of underrecognized genetic and immune factors in chronic wounds and its focus on transformative technologies, such as personalized medicine and digital health. By addressing barriers to accessibility and affordability, it highlights the need for equitable innovations to enhance wound care globally. In addition, this study emphasizes the importance of integrating interdisciplinary approaches that combine molecular biology, immunology, and health technology. It also outlines potential

pathways for translating basic research findings into scalable clinical applications. By bridging gaps between scientific innovation and practical implementation, this review aims to support the development of more effective and inclusive wound care strategies.

CONCLUSION

Chronic wounds remain a major challenge in healthcare, with complex underlying risk factors and limited treatment options. While significant progress has been made in understanding the pathophysiology of chronic wounds, further research is needed to fully unravel the genetic, immunological, and environmental factors that contribute to their development. Evidence-based interventions such as advanced dressings, negative pressure wound therapy, and skin grafting have shown effectiveness, but barriers to accessibility and high treatment costs continue to limit their widespread use.

As chronic wounds become increasingly prevalent worldwide, their management demands a multifaceted, evidence-based approach. Advancements in biomaterials, stem cell therapies, and telemedicine offer promising solutions, but accessibility remains a major barrier, particularly in low-resource settings. Addressing these disparities through policy-driven healthcare reforms and cost-effective treatment strategies is crucial to reducing the health and economic burden of chronic wounds. Moving forward, bridging the gap between technological innovation and clinical application will be key to improving patient outcomes and optimizing wound care on a global scale.

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CONFLICT OF INTEREST

No conflict of interest to be disclosed.

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AUTHOR CONTRIBUTION

VABP contributed to manuscript writing, critical revision, data analysis, and literature review. DSP reviewed, provided expert insights, and approved the final version of the manuscript. EE contributed to manuscript structuring and reviewing relevant literature. MGT was responsible for grammar editing, critical revision, and ensuring coherence in the discussion. HAAT contributed to grammar editing, critical revision, and verification of references for accuracy and relevance. All of the authors approval of this paper for the publishing stages of the research.

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

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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

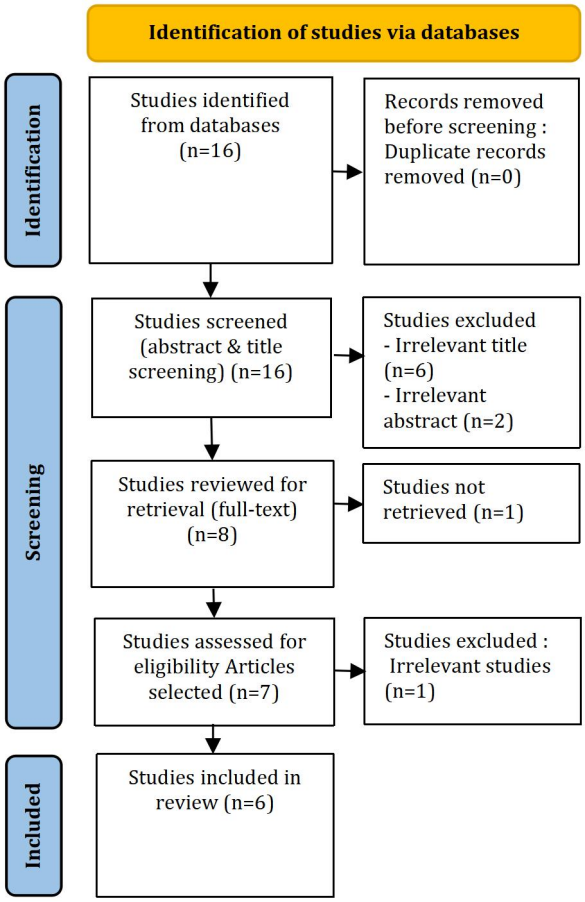

Figure 1. Literature's Selection Process Using PRISMA

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.

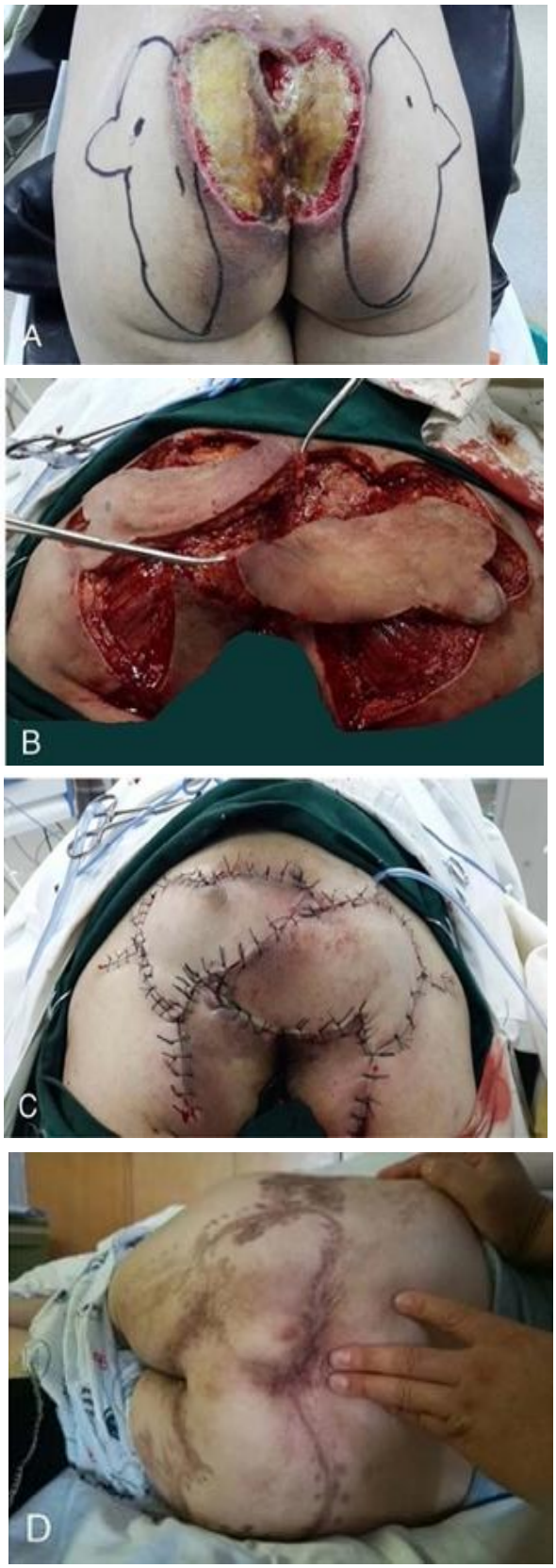

Figure 1. (A) Preoperative appearance of the sacral pressure sore. (B) Clover-style fasciocutaneous perforator flap for wound repair during the operation. (C) The recipient and donor sites were closed in a 1-stage procedure, and a drainage tube was placed under the flap. (D) The flap survived well after 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.

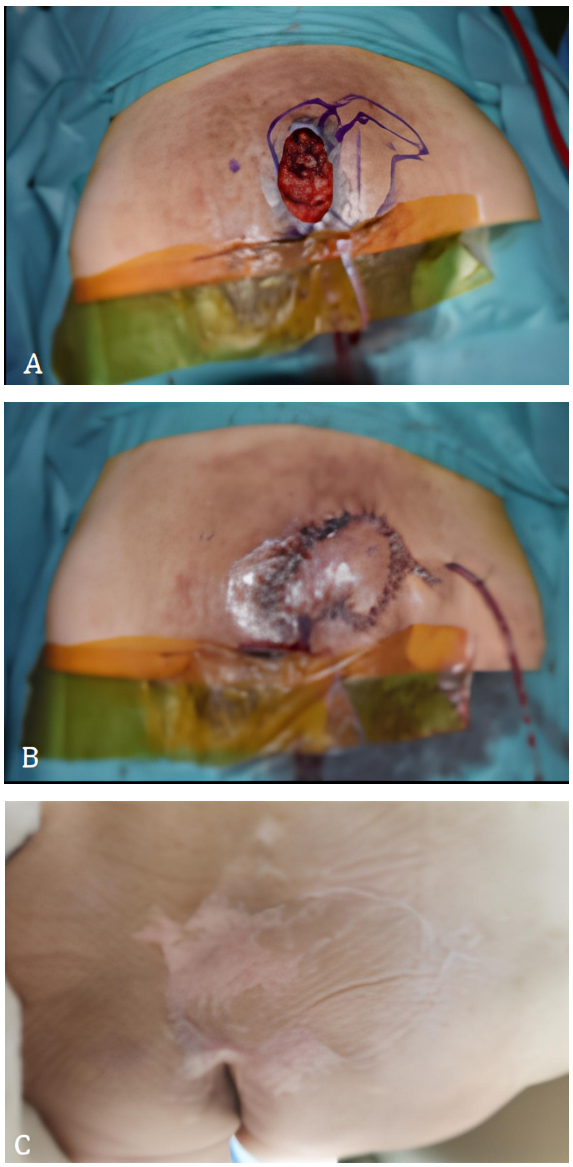

Figure 2. Photographs of case 4 showing a sacral sore (grade 4, size 7 × 4 cm): (A) preoperatively, (B) immediately postoperatively, and (C) at 10 months postoperatively.[9]

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.

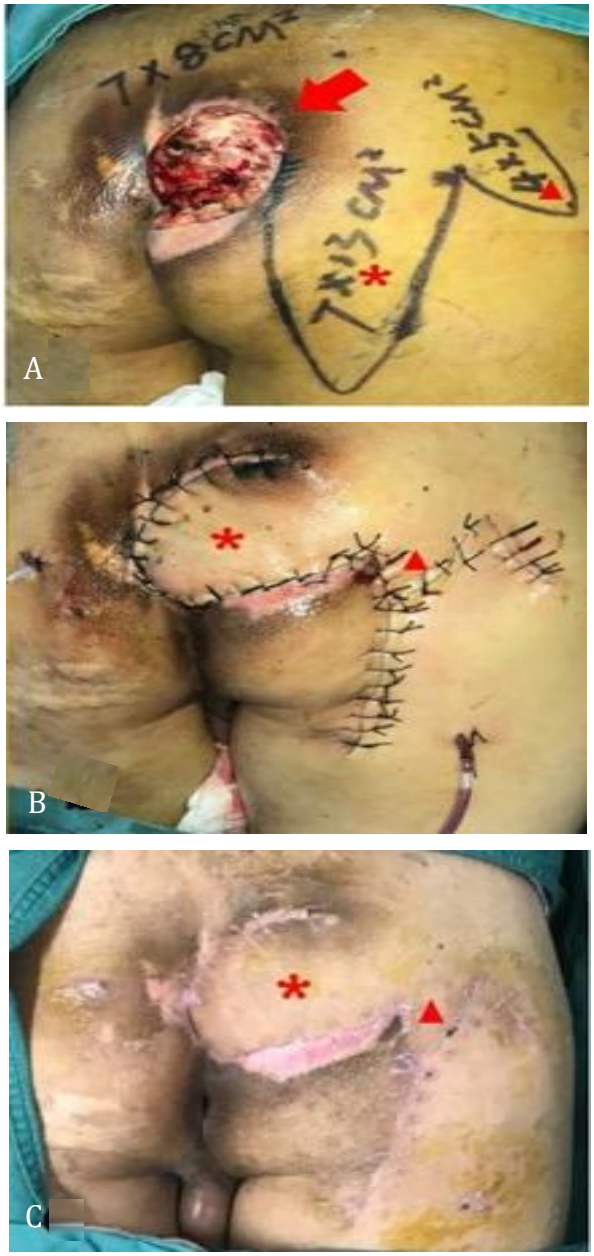

Figure 3. A man with pressure ulcer (stage IV) was treated by the bilobed flap supplied by the superficial branch of superior gluteal artery or the posterior branch of the fourth lumbar artery, (A) before operation; (B) after operation; (C) one year later. Arrow: ulcer position; asterisk: Lobe 1; triangle: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

Discussion

The discussion explains the meaning of the results of the study, does not repeat the results, how the reported results can solve the problems, the differences and similarities with the studies that have been done before, and the possibility of developing the study. This section should include the possibilities for developing further studies, strengths, and limitations of the study. Ensuring that the discussion corresponds to the results should often commence with a brief summary of the main scientific findings (not experimental results). The following components should be covered in the discussion:

1. How does the case/ study relate to the original question or objectives outlined in the introduction section (what/how)?
2. Is scientific interpretation provided for each example of case/study finding presented (why)?
3. Is the case/ study consistent with what other investigators have reported or do differences exist (what else)?

Conclusion

The conclusion is the answer to the question formulation that is asked at the end of the introduction. The conclusions should be based on the results and discussions described earlier. Add suggestions or feedback for further research.

Acknowledgments

Acknowledgments for all research contributors, if any, should be stated briefly on the manuscript before reference.

Conflict of Interest

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Funding Disclosure

The authors should state how the research was funded in this section, including grant numbers if applicable.

Authors' Contributions

All of the authors have contributed to the planning, data collection and analysis, writing, and approval of this paper for the publishing stages of the research.

References

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Reference to a journal publication:

1. Albright JM, Davis CS & Bird MD. The acute pulmonary inflammatory response to the graded severity of smoke inhalation injury. Critical Care Medicine 2012;40: 1113-21.
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1. ISSVA Classification for Vascular Anomalies. 2018. (Accessed 5 October 2019). Available from: https://www.issva.org/UserFiles/file/ISSVA-Classification-2018.pdf
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1. Idrus Jus'at. Penyimpangan positif masalah KEP di Jakarta Utara dan di Pedesaan Kabupaten Bogor Jawa Barat. in Prosiding WNPG VII; 2000. p.153–6.
2. Rachmah Q, Wantanee K. Energy Distribution Of Macronutrients Among Adolescents In Indonesia: Secondary Analysis Of Total Diet Study Data. in 4th Asian Academic Society International Conference (AASIC); 2016. p.170–6.

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1. Sumanto, HRA. Komponen - komponen emas (tesis Doktor). Surabaya: Universitas Airlangga; 1997.
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Patent:

1. Cookson AH. Particle trap for compressed gas insulated transmission systems. US Patent 4554399; 1985.

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