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Superior and Inferior Gluteal Artery Perforator Flaps for Large Sacrococcygeal Pressure Ulcers: Outcomes, Complications and Recurrence in 51 Flaps at a Single Vietnamese Rehabilitation Hospital

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Abstract

Background and objectives: Large stage III–IV sacrococcygeal pressure ulcers that fail conservative care need durable soft-tissue coverage. Superior and inferior gluteal artery perforator (SGAP/IGAP) flaps spare muscle, but Vietnamese series are small and rarely report recurrence. We report flap survival, complications and recurrence in a consecutive single-centre series of 51 flaps. *Materials and Methods*: This retrospective–prospective clinical study included consecutive patients with stage III–IV sacrococcygeal ulcers of at least 6 cm² after debridement who had SGAP/IGAP flap coverage between August 2024 and January 2026. The primary outcome was flap survival with wound closure at the end of initial healing. Secondary outcomes were graded partial necrosis, wound complications, reoperation and recurrence to the last documented follow-up. Flaps with and without an event in a post hoc selected adverse-event composite (composite event) were compared exploratorily. *Results*: Fifty-one flaps in 50 patients were analysed (median age 61 years; spinal cord injury in 24 flaps; median ulcer area 54 cm², range 6–323). Forty-six flaps were SGAP, two IGAP and three combined. All 51 flaps survived with wound closure (100%; 95% CI 93.0–100). Partial necrosis occurred in 3 flaps (5.9%; two involved more than one third of the flap); each needed one reoperation and healed. Five flaps (9.8%) needed some further operation (three during initial healing, two for recurrence), and 17 flaps (33.3%) had a complication of any kind. Dehiscence (n = 4), infection (n = 6), haematoma (n = 3) and seroma (n = 7) were also recorded. Median follow-up was 10.2 months (range 2.8–22.3); two patients were lost. Crude recurrence over variable follow-up was 2 of 49 flaps (4.1%; 95% CI 0.5–14.0), at 17 and 22 months. Eight flaps (15.7%; 95% CI 7.0–28.6) had a composite event; exploratory, unadjusted comparisons suggested larger flap and ulcer areas in these flaps (p = 0.013–0.027), but these did not withstand correction for multiple testing. *Conclusions*: SGAP/IGAP flaps gave reliable flap survival and wound closure in large sacrococcygeal ulcers, but 17 of 51 flaps (33.3%) had a complication of any kind, 5 (9.8%) needed a further operation, about one flap in six (15.7%) had a composite event, every pedicle compression was followed by necrosis and reoperation, and both

Academic Editor: Sjaak Pouwels

Received: 5 October 2026
Revised: 19 November 2026
Accepted: 27 November 2026
Published: 29 November 2026

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recurrences appeared after the median follow-up. Flap survival reflects technical success and should not be equated with durable clinical success. Longer standardised follow-up and larger prospective series with graded complication reporting are needed.

Keywords: pressure ulcer; sacrum; perforator flap; superior gluteal artery perforator flap; inferior gluteal artery perforator flap; spinal cord injury; negative pressure wound therapy

1. Introduction

Sacral pressure injuries are among the most common pressure injuries in people with spinal cord injury, stroke and other causes of prolonged immobility [1]. Stage 3 and 4 injuries involve full-thickness skin loss, may expose bone, and are often undermined and infected [2,3]. Sustained pressure combined with shear reduces tissue perfusion and deforms deep tissue before damage is visible on the skin [4]. When conservative care fails, guidelines support debridement and surgical reconstruction in suitable patients [3].

Reconstructive options include skin grafting, local random-pattern and rotation flaps, and gluteus maximus myocutaneous flaps. Muscle flaps are reliable, but sacrifice gluteal muscle [5], and gluteal fasciocutaneous rotation flaps have been compared with myocutaneous flaps as a muscle-sparing alternative [6]. Perforator flaps based on the superior gluteal artery were introduced for sacral sores in 1993 [7] and refined by Verpaele and colleagues [8]; the inferior gluteal artery offers an alternative source [9]. Propeller designs, in which an island flap is rotated about its perforator, extend the arc of coverage [10–12]. Perforator and rotation flaps have been compared in several series [13,14], including a recent comparison of propeller and advancement flaps [15].

In Vietnam, SGAP flaps for sacrococcygeal ulcers have been reported in single-centre series of 30 to 43 patients [16–18], with good flap survival in about 90% [17,18]. A cadaveric study described a perforator-rich zone within a 6 cm circle over the upper buttock [19], and the anatomy of the inferior gluteal artery has recently been reported [20]. These clinical series, however, used mostly SGAP flaps, defined success in different ways, and said little about complications by type or about recurrence.

Three gaps follow from this literature. First, survival of the flap is not the same as durable healing: a flap can stay perfused while the wound beneath or beside it breaks down. Second, complications are usually reported as a single figure, which hides the difference between a transient wound-edge problem and an event that threatens the reconstruction, such as pedicle compression. Third, recurrence, which dominates the long-term burden of pressure ulcer surgery [21–23], is rarely reported in Vietnamese series, and the inferior gluteal artery has hardly been used clinically in this setting. Rehabilitation hospitals, where many patients with spinal cord injury are treated for months, are a relevant setting because pressure relief, nutrition and wound-bed preparation can be managed under one roof.

We therefore report flap survival, complications and recurrence in 51 consecutive SGAP/IGAP flaps for large sacrococcygeal pressure ulcers at a Vietnamese rehabilitation hospital, and explore, with appropriate caution, which patient and operative characteristics were associated with composite events.

2. Methods

2.1. Design and Setting

This single-centre descriptive clinical study, with retrospective and prospective data collection, was carried out in the Department of Plastic and Reconstructive Surgery, Ho Chi Minh City Hospital for Rehabilitation and Professional Diseases, Ho Chi Minh City, Vietnam. Data for patients operated on from 16 August 2024 to 14 May 2025 were collected retrospectively from the medical records, and data for patients operated on from 15 May 2025 to 27 January 2026 were collected prospectively (prospective collection began on 15 May 2025). Ethical approval was granted on 13 April 2025. The report follows the STROBE statement [24]. All procedures were carried out in accordance with the ethical standards of the institutional and national research committees and the 1964 Declaration of Helsinki and its later amendments, approved by the Ethics Committee of Rehabilitation—Occupational Diseases Hospital, Ho Chi Minh City (No. 336/QĐ-BVPHCN). Written informed consent for surgery and for the use of clinical data for research was obtained from all patients before surgery, and records were coded before analysis.

2.2. Patients

We included consecutive patients with a stage III or IV sacrococcygeal pressure ulcer [2] of at least 6 cm^2 after thorough debridement, who were eligible within the American Society of Anesthesiologists (ASA) physical status I–III range (surgical records showed no patient recorded as ASA class IV–V, but the specific class was not consistently documented and could not be analysed), and in whom standard local treatment (debridement, dressings, negative pressure wound therapy) had failed after at least two weeks or in whom exposed bone could not be covered conservatively. All ulcers included in the study were stage III or IV and met the eligibility criterion. The dataset recorded the specific stage for 43 of the 51 flaps; for the remaining eight, the distinction between stage III and stage IV was not recorded. This incomplete stage-specific documentation is acknowledged as a limitation. Exclusion criteria were ASA class IV–V; uncontrolled coagulopathy; sepsis; an ulcer too large for a single perforator flap; previous gluteal or sacral surgery that could have altered the vascular anatomy; conditions making prolonged prone or lateral positioning unsafe; severe malnutrition or anaemia that could not be corrected; and inability to comply with postoperative care. Operations were performed between 16 August 2024 and 27 January 2026.

The unit of analysis is the flap; age and sex are reported per patient. One patient had two flaps. This patient had a single sacrococcygeal ulcer (10 × 15 cm) reconstructed with a bilateral pair of SGAP flaps, so the study included 50 patients with 50 ulcers reconstructed with 51 flaps. Ulcer-level variables (ulcer area, stage, healing, recurrence and follow-up) were assigned to both flaps, whereas flap-level variables (flap area, perforators, operative details) were recorded for each flap. A reoperation for necrosis of an earlier flap was counted as a complication of the index flap, not as a new flap.

2.3. Sample and Data Handling

No formal sample size calculation was performed: all consecutive eligible patients were treated during the study period, so the precision of each estimate is described by its confidence interval. Data were entered into a spreadsheet from the medical record, checked against operative and discharge dates, and de-identified before analysis; names and addresses were removed, and each patient and flap received a study number. Inconsistent or incomplete entries were clarified with the treating surgeon before the final dataset was fixed, and admission, surgery and discharge dates entered with the wrong year for seven records were corrected from the source records. Operative time was recorded in

minutes from the operative records. Intervals were calculated from admission, surgery, suture removal and discharge dates. Laboratory values were those recorded before surgery. Albumin was missing in two flaps; these were excluded from albumin analyses only, and no values were imputed.

2.4. Preoperative Management and Operative Technique

Necrotic tissue and slough were debrided and undermined pockets opened. NPWT was used at the surgeon's discretion to prepare the wound bed using the PREVENA 125 system (KCI USA, Inc., San Antonio, TX, USA), and nutrition and anaemia were optimised where possible. The same surgical team operated using a uniform protocol, under general anaesthesia, with the patient in the prone or lateral position. Perforators of the superior or inferior gluteal artery near the defect margin were identified with a handheld Doppler (Dopplex DMX with an 8-MHz vascular probe, Huntleigh Healthcare Ltd., Cardiff, UK). A fasciocutaneous island flap was designed on the dominant perforators, with rotation or advancement individualised to the defect; the arc of rotation was not recorded. The flap was dissected from its periphery toward the perforators, keeping a cuff of subcutaneous tissue around the pedicle and without harvesting muscle, and inset with non-absorbable sutures (3-0 or 4-0 polypropylene) over one or two drains. The donor site was closed primarily.

Technical features. This series uses the established SGAP/IGAP technique and does not propose a new flap design; the features that characterised our practice are listed so that readers can reproduce it. The flap was designed on the dominant perforators found near the defect margin (a median of three Doppler signals, range 1–5, was included in the pedicle), and the source artery followed the position of these perforators: superior in 46 flaps, inferior in two and both in three. The flap was a fasciocutaneous island with a cuff of subcutaneous tissue left around the pedicle and no muscle harvested, rotated or advanced according to the defect; one patient had a bilateral pair. Flaps were designed larger than the defect (median flap-to-ulcer area ratio 1.9), the flap was inset over one or two drains, the donor site was closed primarily, and all patients underwent surgery under general anaesthesia. No distinct technical modification of the established technique was introduced.

2.5. Postoperative Care and Follow-Up

Patients lay prone or on their side for at least the first 7 to 10 days; when supine positioning was unavoidable, the head of the bed was kept at or below 15 degrees on a pressure-redistributing mattress [3]. Flap colour, temperature and tension were checked every two hours for 24 h and then three times daily. Intravenous broad-spectrum antibiotics were given for 5 to 7 days, and NPWT was applied after surgery when needed. Postoperative NPWT was applied as closed-incision therapy at the surgeon's discretion. The dressing was placed along the suture line around the flap, leaving a window to monitor flap colour, temperature, capillary refill and Doppler signals, and was set at −125 mmHg in continuous mode. It stayed in place for 7 days and was then replaced with conventional dressings. Suture removal was planned for days 12 to 14. Outpatient visits were planned at 2 weeks, 1, 3 and 6 months. For the final analysis, the date of the last documented follow-up was recorded for every patient, and follow-up duration was the interval from surgery to that date (the later date for the patient with two flaps). The date of the last assessment, which was the last visit at which wound status was recorded, was used to calculate follow-up duration. After the scheduled 6-month visit, wound status was assessed by telephone follow-up and by photographs provided by patients or caregivers. Assessments addressed maintenance of wound closure, new ulceration at the reconstruction site, wound discharge and the need for further intervention. Patients whose wound status

could not be verified were classified as lost to follow-up. Patients who could not be followed, including one transferred to another hospital, were recorded as lost to follow-up. Their last documented visit was used for the duration of follow-up, and they were excluded from the denominator for recurrence.

2.6. Variables and Outcome Definitions

Baseline data were extracted from medical records on a standard form: age, sex, spinal cord injury, ulcer stage and diabetes mellitus as documented in discharge diagnoses, preoperative haemoglobin, serum albumin and C-reactive protein (CRP), ulcer and flap dimensions, source artery, number of perforators, anaesthesia, operative time, NPWT sessions, and dates of admission, surgery, suture removal and discharge. Ulcer area after debridement and flap area were calculated as maximal length × width, which overestimates irregular shapes. The number of perforators was the number of Doppler-audible perforators included in the pedicle. Perforators were mapped preoperatively using a handheld Doppler and marked on the skin to guide flap design. During flap elevation, individual musculocutaneous perforators were dissected, exposed and marked to guide pedicle selection. The reported perforator count is the number of Doppler-audible perforators marked before surgery and included in the flap design; whether each signal corresponded to a distinct vessel that was confirmed and preserved at dissection was not recorded for every case. Flaps were classified as superior, inferior or combined gluteal artery perforator flaps according to the anatomical location of the Doppler-identified perforators, intraoperative findings and operative reports; source-artery assignment did not rely on imaging. The line connecting the posterior superior iliac spine to the greater trochanter and the surface projection of the piriformis muscle served as anatomical landmarks, with superior and inferior gluteal artery perforators sought above and below the piriformis, respectively.

Outcomes were recorded by the treating surgeon on a structured outcome form as present or absent: flap survival (complete, partial or total); partial flap necrosis of any extent, graded as less or more than one third of the flap; total flap necrosis; primary or secondary healing; complete wound healing; wound dehiscence, infection, haematoma and seroma; reoperation and its reason; and recurrence with date, site (same, adjacent or different) and need for reoperation. Where the survival category conflicted with the necrosis fields (one flap), the more specific necrosis fields were used. Bleeding from the ulcer bed or flap and pedicle compression were taken from the medical record; pedicle compression was defined as mechanical compression of the pedicle (tight closure, haematoma or angulation) with a pale, cool flap and loss of the Doppler signal. Recurrence was new ulceration at the flap site after initial healing.

Complication criteria. Complications were recorded by the treating surgeon as present or absent; operational criteria for dehiscence, infection, seroma and bleeding were not predefined, so the reported rates may not be exactly reproducible in other centres. Pedicle compression was defined as above. Osteomyelitis was diagnosed from histopathological examination of intraoperative bone specimens (19 of 50 patients, 38.0%). Management consisted of excision of the ulcer, nonviable soft tissue and, when indicated, infected bone; resected bone was sent for histopathology, and specimens from the remaining bone without gross infection were sent for culture after debridement. Once debridement was adequate, flap cover was done in the same operation to obliterate dead space and close the wound. Antibiotics were started while culture results were awaited and then adjusted according to microbiological findings and the advice of an infectious disease specialist.

The primary outcome was flap survival with wound closure and no conversion to another reconstructive method (assessed at the end of the initial healing episode, when

the index wound was recorded as completely healed; later operations for recurrence were counted as recurrence and not as conversion). Secondary outcomes were partial necrosis, total flap loss, wound healing, the complications above, reoperation and recurrence. Because few events occurred in each category, we defined a selected adverse-event composite post hoc as bleeding, pedicle compression, partial necrosis or recurrence; an event in this composite is called a composite event. The composite is a pragmatic grouping for exploratory comparison and not a severity grade, because its components differ in clinical weight (for example, bleeding without intervention versus necrosis needing surgery). It is therefore labelled as a selected composite: it includes bleeding managed with dressings alone and excludes infection and seroma that needed treatment, so it does not measure the total complication burden, which is reported separately as the proportion of flaps with a complication of any kind. We therefore report each component, its management and the number of flaps needing a further operation separately, and we show early events apart from recurrence, which depends on the length of follow-up.

2.7. Statistical Analysis

Continuous variables are given as mean ± standard deviation or median (interquartile range), categorical variables as number (percentage). Exact (Clopper–Pearson) 95% confidence intervals were calculated for proportions [25]. Recurrence was calculated among flaps not lost to follow-up; with two events and short follow-up, no time-to-event modelling was attempted. Recurrence is reported as the observed crude proportion over variable follow-up, not as a time-adjusted rate. Flaps with and without a composite event were compared with the Mann–Whitney U test and Fisher's exact test. These comparisons were exploratory and two-sided, without adjustment for multiple testing (15 comparisons; a Bonferroni threshold would be $p < 0.003$) and without multivariable modelling given the small number of events. As a sensitivity check, the nominally significant continuous comparisons were repeated without the largest flap. Clustering within the one patient with two flaps was ignored. Analyses used Python 3.13 with SciPy 1.17.

3. Results

3.1. Patients and Flaps

We identified 53 records for 50 patients. Two records documented a reoperation for necrosis of an earlier flap, not a new flap, and were counted with the index flap, leaving 51 flaps in 50 patients (Figure 1). One patient contributed two flaps. Two flaps (two patients) were lost to follow-up, one after transfer to another hospital. Figure 2 shows an illustrative case of bilateral SGAP flap reconstruction, including its long-term appearance.

Patient and ulcer characteristics are shown in Table 1. The 50 patients had a mean age of 57.5 ± 16.4 years (range 20–89), and 31 (62.0%) were men. Spinal cord injury was recorded for 24 of 51 flaps. Where a stage was documented, 35 ulcers were stage IV and 8 stage III. The median ulcer area was 54 cm^2 (IQR 36–80; range 6–323), and 8 ulcers (15.7%) exceeded 100 cm^2. Haemoglobin was below 11 g/dL in 54.9% of flaps, albumin below 30 g/L in 55.1% of 49 measured, and CRP was 10 mg/L or higher in 76.5%.

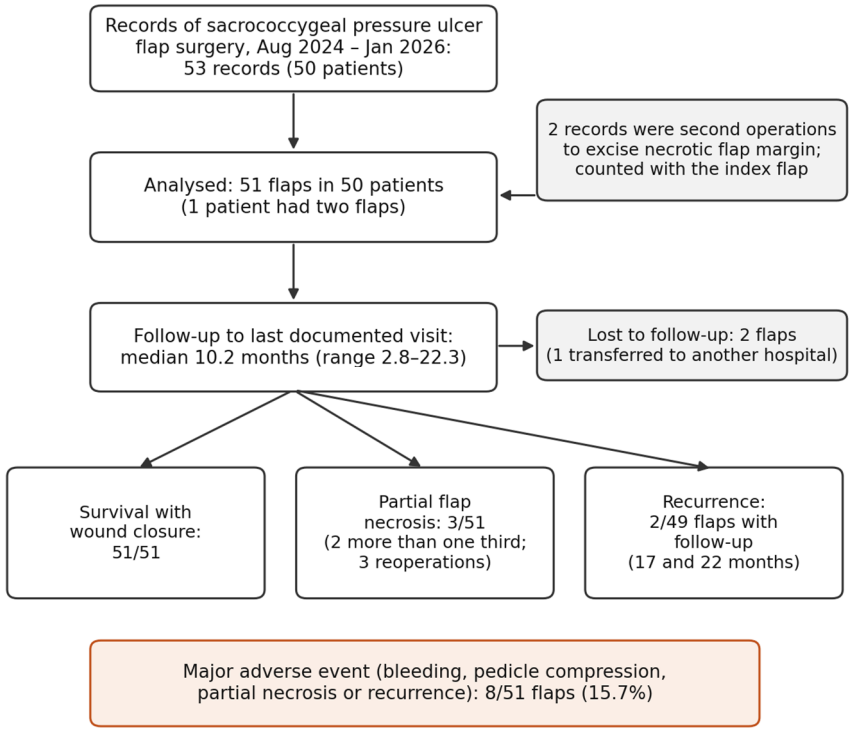


Figure 1. Flow of records, flaps and patients through the study, with follow-up and main outcomes.

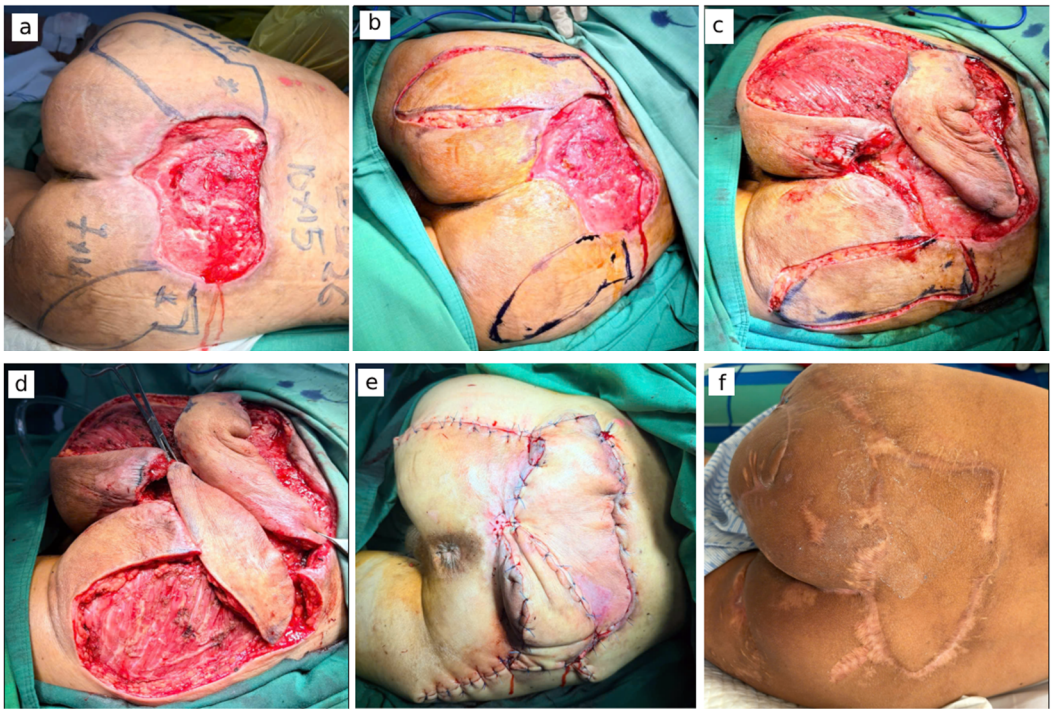


Figure 2. Bilateral SGAP flap reconstruction of a sacrococcygeal pressure ulcer. (**a**) Preoperative view of a sacrococcygeal pressure ulcer measuring 10 × 15 cm. (**b**) Design of bilateral SGAP flaps measuring 8 × 18 cm on the left buttock and 7 × 18 cm on the right buttock. (**c**) Elevation of the bilateral SGAP flaps. (**d**) Medial mobilisation of the flaps toward the defect. (**e**) Inset of the bilateral SGAP flaps for defect coverage. (**f**) Long-term appearance 18 months after surgery.

Table 1. Baseline characteristics of the patients and flaps.

Characteristic	Value
Patients (n = 50)	

Age, years: mean ± SD	57.5 ± 16.4
Age, years: median (IQR); range	61 (48.2–70.5); 20–89
Male sex, n (%)	31 (62.0)
Flaps (n = 51)	
Spinal cord injury, n (%)	24 (47.1)
Diabetes mellitus, n (%)	11 (21.6)
Ulcer stage, n (% of 43 documented): IV	35 (81.4)
Ulcer stage: III	8 (18.6)
Ulcer area after debridement, cm^2: median (IQR)	54 (36–80)
Ulcer area, cm^2: range	6–323
Ulcer area >100 cm^2, n (%)	8 (15.7)
Haemoglobin, g/dL: median (IQR)	10.6 (9.8–11.7)
Haemoglobin < 11 g/dL, n (%)	28 (54.9)
Albumin, g/L: median (IQR), n = 49	29.5 (27.5–33.9)
Albumin < 30 g/L, n/N (%)	27/49 (55.1)
C-reactive protein, mg/L: median (IQR)	25.0 (11.4–46.7)
C-reactive protein ≥ 10 mg/L, n (%)	39 (76.5)
Admission to surgery, days: median (IQR)	15.0 (9.5–27.5)

Values are n (%), mean ± SD or median (IQR) unless stated. Age and sex are per patient (n = 50); other variables per flap (n = 51). Ulcer stage was documented for 43 flaps; stage and diabetes were taken from discharge diagnoses. IQR—interquartile range;

3.2. Operative Characteristics

Operative characteristics are shown in Table 2. Forty-six flaps (90.2%) were based on the superior gluteal artery, two (3.9%) on the inferior gluteal artery, and three (5.9%) on both. The pedicle contained a median of 3 Doppler-audible perforators (range 1–5). The median flap area was 98 cm^2 (IQR 76.5–151.5; range 24–440), about twice the ulcer area. Operative time had a median of 70 min (range 30–210); all flap reconstructions were performed under general anaesthesia. NPWT was used before surgery in 17 flaps and after surgery in 22. Sutures were removed at a median of 19 days (range 11–34), and the median hospital stay was 45 days (IQR 33.5–57).

Table 2. Operative and perioperative characteristics (51 flaps).

Characteristic	**Value**
Source artery, n (%)	
Superior gluteal artery only	46 (90.2)
Inferior gluteal artery only	2 (3.9)
Superior and inferior	3 (5.9)
Flap and operation	
Doppler-audible perforators, median (range)	3 (1–5)
Flap area, cm^2: median (IQR)	98.0 (76.5–151.5)
Flap area, cm^2: range	24–440
Flap-to-ulcer area ratio: median	1.9
General anaesthesia, n (%)	51 (100)
Operative time, min: median (IQR)	70.0 (60.0–85.0)
Operative time, min: range	30–210
Negative pressure wound therapy	
Before surgery, n (%)	17 (33.3)
After surgery, n (%)	22 (43.1)
At any time, n (%)	24 (47.1)
Course	
Suture removal, postoperative day: median (IQR); range	19 (16–21); 11–34

Postoperative stay, days: median (IQR)	24.0 (14.0–35.0)
Total hospital stay, days: median (IQR)	45.0 (33.5–57.0)
Follow-up	
Months from surgery to last documented follow-up: median (IQR)	10.2 (7.1–15.3)
Months of follow-up: range	2.8–22.3
Followed for at least 12 months, n (%)	21 (41.2)
Followed for at least 12 months among the 49 flaps in the recurrence analysis, n (%)	19 (38.8)
Lost to follow-up, n (%)	2 (3.9)

Values are n (%), mean ± SD or median (IQR) unless stated. Perforators, number of Doppler-audible perforators in the pedicle. Areas are length × width. SGAP—superior gluteal artery perforator;

3.3. Outcomes, Complications and Follow-Up

Outcomes are shown in Table 3. All 51 flaps survived with wound closure at the end of initial healing, and none was converted to another reconstruction (100%; 95% CI 93.0–100); no flap was lost completely. Three flaps (5.9%) developed partial necrosis, which involved more than one third of the flap in two and less than one third in one. Each of these three needed one reoperation (for necrosis in two flaps and for haematoma in one), healed by secondary intention, and had complete wound healing. The other 48 flaps (94.1%) healed primarily, and complete wound healing was recorded in all 51.

Wound dehiscence occurred in 4 flaps (7.8%), infection in 6 (11.8%), haematoma in 3 (5.9%) and seroma in 7 (13.7%). The three haematomas were the same three flaps with pedicle compression, and these were also the three flaps with partial necrosis. Bleeding from the ulcer bed or flap occurred in 4 other flaps (7.8%), none of which developed necrosis. All four bleeding episodes (flaps 1, 2, 4 and 6) were managed conservatively with haemostatic dressings. Three other flaps (12, 27 and 46) developed haematoma with pedicle compression and subsequently partial necrosis; each required one reoperation. Four flaps had wound dehiscence, six had infection and seven seroma, and more than one complication could occur in the same flap. Flaps 12 and 46 had partial necrosis with dehiscence, infection, and haematoma, and each required one reoperation for necrosis; flap 27 required one reoperation for haematoma. The other two dehiscences were minor and healed with local wound care and dressing changes, without reoperation. For infection, wound samples were sent for culture and susceptibility testing, and treatment was culture-directed antibiotics with local wound care. Two of the seven seromas were aspirated at the bedside, and the other five were managed with local care and observation. In total, 17 of the 51 flaps (33.3%; 95% CI 20.8–47.9) had a complication of any kind (bleeding, necrosis, dehiscence, infection, haematoma, seroma or recurrence).

The median follow-up from surgery to the last documented visit was 10.2 months (IQR 7.1–15.3; range 2.8–22.3), and 21 flaps (41.2%) had been followed for at least 12 months (including the two flaps lost to follow-up, whose documented follow-up was 14.6 and 15.3 months; 19 were among the 49 flaps in the recurrence analysis). Two flaps were lost to follow-up. Recurrence at the same site occurred in 2 of 49 flaps with follow-up (crude proportion 4.1%; 95% CI 0.5–14.0, over variable follow-up), 22.3 and 17.3 months after surgery; both were among the 7 flaps followed for at least 17 months. Counting the two flaps lost to follow-up, the proportion would be 2 of 51 (3.9%; 95% CI 0.5–13.5) if neither had recurred and 4 of 51 (7.8%; 95% CI 2.2–18.9) if both had. Both were treated with debridement and a local flap. Overall, 8 flaps (15.7%; 95% CI 7.0–28.6) had at least one composite event (12 events in total), and 43 flaps had none. Seven flaps (13.7%; 95% CI 5.7–26.3) had an early composite event (bleeding or pedicle compression with necrosis);

the eighth flap had recurrence only, and one of the two flaps with recurrence also had early bleeding.

Reoperations. During initial healing, 3 flaps (5.9%) returned to theatre (necrosis in two, haematoma in one). The two recurrences were treated later with debridement and a local flap and occurred in different flaps. In total, 5 of 51 index flaps (9.8%; 95% CI 3.3–21.4) needed a further operation: three early and two late.

Table 3. Outcomes and complications.

Outcome	n/N	%	95% CI, %
Flap and wound healing (51 flaps)			
Survival with wound closure, no conversion	51/51	100	93.0–100
Total flap loss	0/51	0.0	0.0–7.0
Complete survival without any necrosis	48/51	94.1	83.8–98.8
Partial flap necrosis, any extent	3/51	5.9	1.2–16.2
Necrosis of more than one third of the flap	2/51	3.9	0.5–13.5
Necrosis of less than one third of the flap	1/51	2.0	0.0–10.4
Primary healing	48/51	94.1	83.8–98.8
Secondary healing	3/51	5.9	1.2–16.2
Complete wound healing	51/51	100	93.0–100
Complications and reoperation (51 flaps)			
Wound dehiscence	4/51	7.8	2.2–18.9
Wound infection	6/51	11.8	4.4–23.9
Haematoma (all with pedicle compression)	3/51	5.9	1.2–16.2
Seroma	7/51	13.7	5.7–26.3
Bleeding from ulcer bed or flap	4/51	7.8	2.2–18.9
Pedicle compression	3/51	5.9	1.2–16.2
Reoperation during initial healing	3/51	5.9	1.2–16.2
Any further operation (reoperation during healing or surgery for recurrence)	5/51	9.8	3.3–21.4
Any complication of any kind (including bleeding)	17/51	33.3	20.8–47.9
Long-term outcome (49 flaps with follow-up)			
Recurrence at the flap site, crude proportion (treated by debridement and local flap)	2/49	4.1	0.5–14.0
Composite (post hoc, 51 flaps)			
Composite event (selected adverse-event composite), at least one	8/51	15.7	7.0–28.6
Early composite event (bleeding or pedicle compression), at least one	7/51	13.7	5.7–26.3
No composite event	43/51	84.3	71.4–93.0

CI—exact (Clopper–Pearson) 95% confidence interval. All outcomes use 51 flaps except recurrence (49 flaps not lost to follow-up). One flap recorded as complete survival had necrosis of more than one third and is counted under partial necrosis. Haematoma occurred in the same three flaps as pedicle compression. The composite event is a post hoc selected composite of bleeding, pedicle compression, partial necrosis or recurrence (12 events in 8 flaps). Reoperation refers to operations during initial healing; the two recurrences were treated later with debridement and a local flap and are counted as further operations. Recurrence is the crude proportion over variable follow-up.

3.4. Hospital Course and the Eight Flaps with Composite Events

The median interval from admission to surgery was 15 days (IQR 9.5–27.5; range 3–44), reflecting debridement, wound-bed preparation and medical optimisation. After surgery, patients stayed in hospital for a median of 24 days (IQR 14–35). Among the 17 flaps

with preoperative NPWT, the median number of sessions was one (range 1–3); among the 22 with postoperative NPWT, it was two (range 1–7).

The eight flaps with a composite event came from eight different patients operated on between August 2024 and December 2025. Three had bleeding only, one had bleeding and later recurrence, one had recurrence only, and three had pedicle compression followed by partial necrosis; one of these three was the largest ulcer in the series (323 cm^2) with the largest flap (440 cm^2). By source artery, 7 of 46 SGAP-only flaps, 1 of 2 IGAP-only flaps (bleeding) and none of the 3 combined flaps had a composite event.

3.5. Exploratory Comparison

Table 4 and Figure 3 compare the eight flaps with a composite event with the 43 without. Flaps with events had a larger median flap area (185 versus 98 cm^2, $p = 0.013$), larger ulcer area (100 versus 48 cm^2, $p = 0.027$) and more perforators (4 versus 3, $p = 0.024$), and an ulcer area above 100 cm^2 was more frequent (4 of 8 versus 4 of 43, $p = 0.015$). Lower haemoglobin (9.7 versus 10.8 g/dL, $p = 0.072$) and longer operative time (80 versus 70 min, $p = 0.087$) showed the same trend. For age, sex, spinal cord injury (4 of 8 versus 20 of 43 flaps), albumin, CRP, and preoperative NPWT, no statistically significant differences were detected. None of the comparisons survived correction for 15 tests, and without the largest flap, the flap-area, perforator, and ulcer-area comparisons became $p = 0.038$, 0.043, and 0.073. Flap and ulcer area were strongly correlated (Spearman $\rho = 0.87$), so their effects cannot be separated. Seven of the eight flaps with a composite event had an early event, so the comparison mainly reflects early complications.

Table 4. Flaps with and without a composite event (exploratory).

Variable	Composite Event (n = 8)	No Composite Event (n = 43)	*p*
Age at surgery, years	58 (38–73)	61 (48–69)	0.969
Haemoglobin, g/dL	9.7 (9.4–10.4)	10.8 (10.1–12.0)	0.072
Albumin, g/L	29.0 (25.0–31.4)	29.9 (27.8–33.9)	0.482
C-reactive protein, mg/L	22.7 (16.0–48.7)	25.2 (9.2–46.3)	0.717
Ulcer area, cm^2	100.0 (57.2–150.0)	48.0 (36.0–71.0)	0.027
Flap area, cm^2	185.0 (117.0–234.0)	98.0 (75.0–142.0)	0.013
Doppler-counted perforators, n	4 (4–4)	3 (3–4)	0.024
Operative time, min	80 (70–91)	70 (60–80)	0.087
Male sex	5/8 (62.5)	27/43 (62.8)	1.000
Spinal cord injury	4/8 (50.0)	20/43 (46.5)	1.000
SGAP-only flap	7/8 (87.5)	39/43 (90.7)	1.000
Preoperative NPWT	3/8 (37.5)	14/43 (32.6)	1.000
Ulcer area > 100 cm^2	4/8 (50.0)	4/43 (9.3)	0.015
Albumin < 30 g/L (n = 49)	6/8 (75.0)	21/41 (51.2)	0.269
Haemoglobin < 11 g/dL	6/8 (75.0)	22/43 (51.2)	0.269

Values are median (IQR) or n/N (%). Mann–Whitney U test for continuous variables and Fisher's exact test for categorical variables; exploratory, unadjusted for 15 comparisons (Bonferroni threshold $p < 0.003$). Albumin was missing in 2 flaps without events. SGAP, superior gluteal artery perforator; NPWT, negative pressure wound therapy.

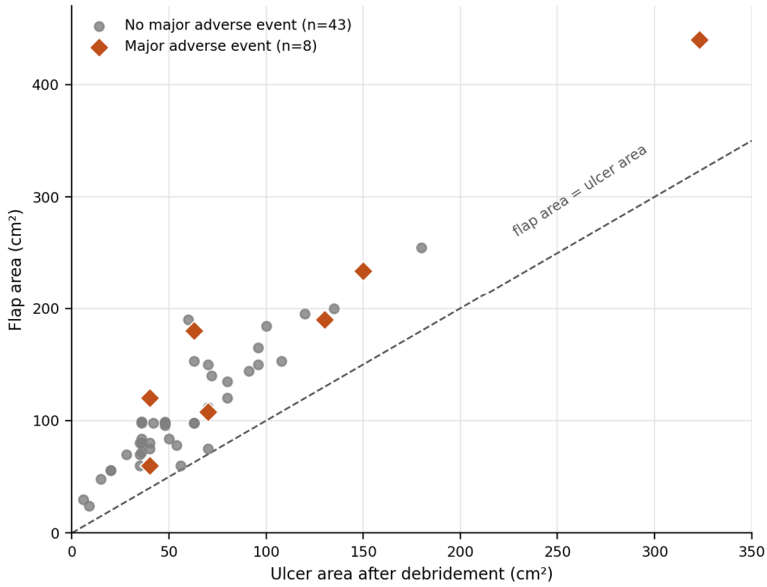


Figure 3. Flap area against ulcer area for the 51 flaps. Diamonds mark the eight flaps with a composite event. The dashed line shows flap area equal to ulcer area.

4. Discussion

In this series of 51 SGAP/IGAP flaps for large sacrococcygeal pressure ulcers, every flap survived, and every wound closed without conversion to another reconstruction. Behind that headline, 17 of 51 flaps (33.3%) had a complication of any kind, 5 (9.8%) needed a further operation, three flaps (5.9%) developed partial necrosis and needed reoperation, eight (15.7%) had at least one composite event, and two of 49 flaps with follow-up (4.1%) recurred. These figures describe the clinical course more honestly than survival alone, because survival credits a flap that stays alive even when the wound it was meant to protect does not heal without further intervention.

A result of 51 survivors out of 51 does not mean that the true failure rate is zero. The exact 95% confidence interval for survival runs from 93.0% to 100%, so failure rates up to about 7% are compatible with our data, and the interval for the composite event rate (7.0% to 28.6%) is wider still. The 16% composite is the better summary of the risk to which a patient is exposed, and the 100% survival figure is one component of it.

Flap survival measures technical success, that is, whether the flap stayed alive and closed the defect. It does not show that the reconstruction was uncomplicated or durable. In our series, 48 of 51 flaps (94.1%) healed without necrosis, 34 of 51 (66.7%) had no complication of any kind, 43 of 51 (84.3%) had no composite event, and 5 of 51 (9.8%) needed a further operation, so the proportion of uncomplicated, durable reconstructions is lower than the 100% survival figure and will fall further with longer follow-up. We regard 100% flap survival as evidence of technical reliability, not as equivalent to uncomplicated or durable success. Durable (clinical) success also requires recurrence-free healing, which depends strongly on patient-related factors that surgery does not remove, such as continued pressure and shear, immobility, poor nutrition and comorbidity [3,21–23]. Spinal cord injury was present in 47% and diabetes in 22% of our flaps, and anaemia and hypoalbuminaemia were common; with two recurrences, we could not examine which of these factors mattered. We therefore suggest that series report technical success, early complications and recurrence-free healing separately.

Flap survival was in line with Vietnamese series reporting good outcomes in about 90% of SGAP flaps [17,18], although those studies defined a good outcome differently and followed patients for a short time. Early reports of gluteal perforator flaps for sacral sores

likewise described favourable results in small groups [7,8]. Comparisons of perforator flaps with rotation or advancement flaps exist [13–15], but our series had no comparison group, and we make no claim of superiority over rotation or muscle flaps.

The reliability of gluteal artery perforator flaps for sacral pressure ulcers is already documented [7,8,13,14], and we do not claim novelty for the flap itself. The contribution of this series is different: it reports consecutive flaps from one team in a rehabilitation hospital, where spinal cord injury is common and wound-bed preparation is prolonged; it includes inferior and combined superior–inferior pedicles, which have rarely been used clinically in Vietnam; it separates technical success, early complications, reoperations and recurrence instead of giving a single success figure; and it reports the timing of recurrence, which Vietnamese series have rarely done [16–18].

Bleeding and pedicle compression are probably technical and, in part, preventable. A haematoma or tight closure beneath a flap supplied by few perforators can compress the pedicle, as can kinking or stretching during rotation [11,12]. All three flaps with pedicle compression had a haematoma, later developed partial necrosis and needed reoperation, whereas none of the four flaps with bleeding developed necrosis. This suggests that compression carries more risk to the flap than bleeding as such, but with three flaps it is an observation to test rather than a finding. Practical safeguards are careful haemostasis before inset, drainage, tension-free closure and inspection of the pedicle after rotation.

Partial necrosis was the only complication that threatened the reconstruction. In two of the three affected flaps, it involved more than one third of the flap. All three needed a further procedure and healed by secondary intention, a favourable end result but a real burden: the three index admissions lasted 50, 68 and 89 days. How reoperations are counted changes the apparent success rate. We counted them as complications of the index flap rather than as new flaps and suggest that series report reoperation separately from survival. Dehiscence (7.8%), infection (11.8%) and seroma (13.7%) were more frequent than necrosis but did not threaten the flap.

Prevention of composite events. Because about one flap in six had a composite event, prevention deserves more attention than survival. Our data point to four targets, which are suggestions from a small series and have not been tested. First, all three flaps with necrosis had a haematoma with pedicle compression, and bleeding occurred in four further flaps; measures that follow directly are meticulous haemostasis of the ulcer bed and flap before inset, drains beneath the flap, closure without tension, and inspection of the pedicle and its Doppler signal after inset and on the first postoperative days, so that a haematoma is evacuated before it compromises the pedicle [11,12]. Second, events occurred in 4 of 8 ulcers larger than 100 cm^2 and in 4 of 43 smaller ones (exploratory), so for very large defects the higher risk should be discussed with the patient and the flap design and pedicle protection planned with particular care. Third, anaemia and hypoalbuminaemia were common, and haemoglobin tended to be lower in flaps with events, so correcting anaemia, controlling infection and optimising nutrition before surgery is reasonable, although our data cannot show that it prevents events. Fourth, to prevent recurrence, discharge planning should include a written pressure-relief and positioning plan, caregiver education and review beyond 6 months [21–23].

Most flaps (46 of 51) were based on the superior gluteal artery, the usual first choice because its perforators emerge close to the sacrococcygeal defect [7,8]; a cadaveric study described a perforator-rich zone over the upper buttock [19]. The inferior gluteal artery was used alone in two flaps and with the superior artery in three. It provides a second source when the superior territory is unsuitable [9], and its anatomy has been described in Vietnamese cadavers [20]. We saw one composite event (bleeding) among five flaps using the inferior artery, which shows feasibility but does not allow comparison with SGAP flaps.

Flaps with events had a larger median flap area, a larger ulcer area and more perforators in the pedicle, a pattern that fits the idea that bigger defects need bigger flaps with a longer lever on the pedicle. This is hypothesis-generating at most. The comparisons were unadjusted; the *p*-values (0.013 to 0.027) did not survive correction for 15 tests; they moved toward 0.04 to 0.07 when the largest flap was set aside, and flap and ulcer area were closely correlated. The perforator count was a Doppler count that was not confirmed at dissection or by imaging, so its association with events remains exploratory and should be interpreted cautiously. No statistically significant difference in outcome was detected by spinal cord injury status. Multivariable analyses in larger series have identified predictors of failure [23]; our data cannot support such models.

The patients were physiologically compromised. Median haemoglobin was 10.6 g/dL, median albumin 29.5 g/L and median CRP 25.0 mg/L; 55% were anaemic by the 11 g/dL threshold used here, 55% had albumin below 30 g/L and 77% had CRP of 10 mg/L or more. Low albumin in this setting reflects systemic inflammation as well as poor intake and should not be read as a pure nutritional marker. Haemoglobin was lower in flaps with events (9.7 versus 10.8 g/dL, $p = 0.072$), and a clinically important effect cannot be excluded. The median interval of 15 days between admission and surgery shows that preparation was substantial, which likely contributed to the low rate of flap loss and is a reason for caution when extrapolating to hospitals that operate soon after admission.

Recurrence is the main long-term failure of pressure ulcer surgery and depends largely on pressure relief after discharge [21–23]. Two flaps recurred at the same site, 17 and 22 months after surgery, and both needed debridement and a local flap. The observed crude proportion of 4.1% (95% CI 0.5% to 14.0%), calculated over variable follow-up and not adjusted for time at risk, is probably an underestimate: median follow-up was 10.2 months, only 19 of the 49 flaps with follow-up had been observed for at least 12 months, and both recurrences occurred later than the median follow-up. With two events, we could not examine what distinguished these patients. Follow-up over several years, with a written pressure-relief plan, is needed before a recurrence rate can be quoted with confidence.

Hospital stay was long, with a median of 45 days overall and 24 days after surgery. This reflects the rehabilitation setting, in which patients with spinal cord injury also undergo pressure-relief training and mobilisation, and it cannot be compared with acute surgical wards. Sutures were planned for removal on days 12 to 14 but were removed at a median of 19 days (range 11 to 34), suggesting surgeons waited longer than planned, likely because of slower healing or caution in high-risk patients.

NPWT was used before surgery in 33% of flaps and after surgery in 43%. It is established for wound bed preparation [26], but evidence in pressure ulcers is uncertain [27], and our non-randomised data cannot show whether it influenced outcomes; no statistically significant difference in composite events was detected with and without preoperative NPWT (3 of 17 versus 5 of 34 flaps). Operative time was short (median 70 min), but debridement and positioning were not standardised. Flaps were designed generously (median flap-to-ulcer area ratio 1.9), which partly reflects the length × width method used to measure irregular shapes. More broadly, flap selection should be individualised according to ulcer size, patient mobility and reconstructive goals [28].

Four practical points follow. First, the pedicle should be inspected after rotation or inset and the Doppler signal rechecked, because every compression was followed by necrosis and reoperation. Second, complications should be recorded in graded, separate categories, and reoperations reported separately from flap survival. Third, follow-up should be scheduled beyond 6 months and documented, because both recurrences appeared after 17 months. Fourth, a written pressure-relief and positioning plan, with caregiver education, should be part of discharge planning.

Strengths and Limitations

Strengths of this study are the consecutive inclusion of patients, one surgical team and protocol, analysis by flap with the patient identified, a documented date of last follow-up for every patient, graded reporting of necrosis and wound complications, exact confidence intervals, and a transparent account of how reoperations were counted.

This study has several limitations. It is a single-centre, single-arm study with mixed retrospective and prospective data, so selection and information bias are possible; patients unable to comply with postoperative care or with uncorrectable malnutrition were excluded, which favours good outcomes. Follow-up was short (median 10.2 months, 41% followed for 12 months or more), and the planned visit schedule ended at 6 months, whereas both recurrences appeared later, so recurrence and late complications are probably under-ascertained; two patients were lost. Complications were recorded as present or absent without severity grading, except for necrosis, and donor-site morbidity was not recorded. The composite endpoint combines early events with recurrence, which are observed over different periods, and does not distinguish minor from serious events. Operational criteria for complications were not predefined, and osteomyelitis (19 patients) was not analysed as a risk factor for outcomes. Ulcer stage and diabetes status were obtained from discharge diagnoses. The specific ulcer stage was recorded for 43 of 51 flaps; for the remaining eight, review of the original clinical records confirmed stage III–IV eligibility, but the exact stage was not recorded in the dataset; BMI, mobility and wound culture data were unavailable. Surgical records showed no patient recorded as ASA class IV–V, but specific ASA classes were inconsistently documented and could not be analysed, so eligibility within ASA I–III rests on these records and not on a recorded class for every patient. Areas were length × width, and perforators were counted by Doppler without imaging and were not confirmed at dissection. Some entries (for example, NPWT sessions and some dates) were reconciled with the treating surgeon rather than with primary documents, and the survival category of one flap conflicted with its necrosis fields. Flaps within the one patient with two flaps were treated as independent; there were only eight composite events, the composite was defined post hoc, and no multiplicity adjustment was made, so the comparisons are exploratory.

Findings from a single rehabilitation hospital, in which about half of the patients had spinal cord injury and wound-bed preparation was prolonged, may not apply to other settings or to surgeons earlier in their learning curve. Patient-reported outcomes, donor-site morbidity and costs were not collected.

5. Conclusions

SGAP/IGAP perforator flaps gave reliable flap survival and wound closure in large sacrococcygeal pressure ulcers, but flap survival measures technical success and not durable clinical success: 17 of 51 flaps (33.3%) had a complication of any kind, 5 (9.8%) needed a further operation, about one flap in six (15.7%) had a composite event, every pedicle compression was followed by partial necrosis and reoperation, and two of 49 flaps recurred after 17 and 22 months, a proportion that probably underestimates long-term recurrence. Meticulous haemostasis and pedicle protection are the most obvious early preventive measures. Larger prospective studies with graded complication reporting, follow-up of at least two years and an explicit pressure-relief protocol are needed.

Author Contributions: Surgical and medical practices: N.V.T. and D.T.H. Concept and design: N.V.T., D.T.H., N.V.L., P.N.C. and C.-Y.H. Data collection and processing: N.V.T. and D.T.H. Analysis or interpretation: N.V.T., D.T.H. and C.-Y.H. Literature search: N.V.T., D.T.H. and C.-Y.H. Writing: N.V.T. and D.T.H. All authors approved the final manuscript. All authors have read and agreed to the published version of the manuscript.

https://doi.org/10.3390/medicina62122358

Funding: This research received no external funding.

Institutional Review Board Statement: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Approved by the Ethics Committee of Rehabilitation—Occupational Diseases Hospital, Ho Chi Minh City (No. 336/QĐ-BVPHCN, 13 April 2025).

Informed Consent Statement: Written informed consent for surgery and the use of clinical data for research purposes was obtained from all patients preoperatively. Written consent for publication of the clinical photographs and relevant case details was obtained from the patient and is documented in the signed consent form.

Data Availability Statement: The de-identified dataset is available from the corresponding author on reasonable request.

Acknowledgments: The authors gratefully acknowledge Can Tho University of Medicine and Pharmacy, Can Tho, Vietnam, and Ho Chi Minh City Hospital for Rehabilitation and Professional Diseases, Ho Chi Minh City, Vietnam, for their support during the preparation of this manuscript.

Conflicts of Interest: The authors declare that they have no conflicts of interest.

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