

Rectangular Advancement Flap for Recurrent Pilonidal Sinus: A Novel 'Bridge Stone' Technique to Eliminate Midline Corner Tension

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Abstract

Background: Although many surgical techniques have been described for the treatment of pilonidal sinus disease (PSD), they still have high recurrence rates. Flap procedures are the primary method in treating recurrent disease, but recurrences in the flap often stem from flap corners located at or near the midline. While the Limberg flap (LF) leaves the lower and upper corners at the midline, the oval excision of the Karydakis flap causes both ends to approach the midline. To address this problem, we describe a novel rectangular advancement flap, called the 'bridge stone flap', which completely eliminates all midline corners and provides a smooth midline closure.

Methods: A retrospective analysis of 26 patients (24 male, 2 female; median age 25.0 years) with recurrent PSD who underwent rectangular advancement flap repair between August 2021 and January 2026 was performed. The median follow-up was 28 months. Data on demographics, operative details, postoperative complications, healing time, recurrence, and patient satisfaction were collected.

Results: The median operative time was 45 minutes (IQR:35–54), and the median hospital stay was 1 day (1–3). Postoperative complications occurred in five patients (19.2%): seroma (n = 2), flap edema (n = 2), and wound infection (n = 1). No flap necrosis or hematoma was observed. The median time to complete wound healing was 14 days (7–21). At a median follow-up of 28 months (IQR: 13–35), only one patient (3.8%) developed recurrence. The recurrence-free survival at 24 months was 96.2%. Patient satisfaction was high, with a median score of 9/10.

Conclusion The rectangular advancement flap is a safe and effective option for recurrent PSD. By relocating all flap corners at least 2 cm away from the midline and achieving a tension-free straight-line closure, this technique addresses the biomechanical weak points implicated in corner-origin recurrence. The technique is simple, has a short learning curve, and avoids the geometric drawbacks of rhomboid and ovoid flaps. These preliminary results warrant further evaluation in larger comparative studies with extended follow-up.

INTRODUCTION

Pilonidal sinus disease (PSD) is a chronic inflammatory condition affecting the sacrococcygeal region, predominantly in young adults. Despite numerous surgical techniques described, from simple primary closure to complex flap reconstructions, the ideal method remains controversial due to variable recurrence rates [1, 2]. While primary closure is associated with recurrence rates as high as 15–20%, flap techniques such as the Limberg flap (LF) and Karydakis flap have significantly reduced these rates to below 5–7% in most series [3, 4].

However, even with flap surgeries, recurrence is not entirely eliminated. Wound complications associated with flaps for PSD are most frequently observed in the distal portion of the wound. [5] Kaplan et al. have elegantly shown, through a case-control study, that the distance of the wound from the midline predicts uneventful healing and a reduction in wound complications. Recent meta-analyses have focused on

technical modifications to further reduce failure rates. A particular point of interest is the geometry of the flap and its relationship to the midline. Kaplan et al. objectively demonstrated that the distance between the distal scar and the midline is an independent risk factor for recurrence; the closer the scar (or a corner of the flap) is to the midline, the higher the risk of relapse [5]. Their findings suggest that maintaining a distance of at least 2 cm from the midline is advisable. This finding has spurred modifications to classical flaps. For instance, the "modified Limberg flap" (MLF), where the inferior corner is shifted laterally away from the midline, has shown superior outcomes compared to the classical Limberg flap, with significantly lower recurrence rates in comparative studies [6, 7].

In our clinical practice, we made a similar observation: in patients who underwent flap repair and subsequently developed a recurrence, the recurrence almost invariably originated from one of the corners of the flap. Specifically, we noted that when a corner was located on or near the midline, it acted as a stress riser and a nidus for hair insertion and infection. This led us to hypothesize that a flap design which completely eliminates all corners from the midline might offer a theoretical advantage.

To address this, we developed a novel advancement flap, named "bridge stone" flap. Unlike rhomboid (Limberg) flaps, our technique creates a linear closure over the midline without any acute angles. Furthermore, by design, all corners of the flap are positioned laterally, away from the high-risk midline zone. In this paper, we describe the surgical technique of this rectangular advancement (bridge stone) flap and present our preliminary clinical experience with a follow-up of two years.

We hypothesize that by relocating all flap corners away from the midline and achieving a straight-line midline closure, this rectangular flap design minimizes tension concentration at vulnerable points and reduces the risk of recurrence originating from flap corners.

MATERIAL AND METHODS

Study Design and Patient Population

This single-center study was conducted at Mersin University Medical Faculty, Department of General Surgery, Division of Colorectal Surgery Unit, Turkey. A retrospective analysis of a prospectively maintained database was performed. The study was approved by the Mersin University Clinical Research Ethics Committee (approval no: 236/2026) and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all patients.

All consecutive patients who underwent the bridge stone flap (BSF) procedure for recurrent pilonidal sinus disease between August 2021 and January 2026 were considered for inclusion. Recurrence was defined as the reappearance of symptoms (pain, discharge, or abscess) after complete wound healing from the index surgical procedure. In this study, all patients had recurrent disease at baseline; therefore, postoperative recurrence refers to re-recurrence after the bridge stone flap procedure.

The inclusion criteria were: (1) age ≥ 18 years, (2) diagnosis of recurrent PSD based on clinical examination, (3) failure of at least one previous surgical intervention, and (4) disease extent suitable for a unilateral rectangular advancement flap as determined by the operating surgeon. Exclusion criteria were: (1) primary (non-recurrent) PSD, (2) acute pilonidal abscess requiring emergency drainage at the time of presentation, (3) known coagulation disorders, and (4) American Society of Anesthesiologists (ASA) score $\geq$ IV.

During the study period, 30 patients with recurrent PSD were evaluated for this technique. Of these, 2 patients were excluded because they underwent bilateral flap procedures due to extensive disease involving both gluteal regions, and 2 patients did not meet the inclusion criteria (one was 17 years old, one had an acute abscess). The remaining 26 patients formed the final study cohort. No patients were lost to follow-up during the median observation period of 28 months; all 26 patients completed their scheduled follow-up visits.

Data Collection

Data collected included age, sex, body mass index (BMI), smoking status, comorbidities, number and type of previous surgeries, operative time, hospital stay, postoperative complications, time to complete wound healing, visual analog scale (VAS) pain score on postoperative day 1, patient satisfaction (1–10), and recurrence during follow-up. Complete wound healing was defined as full epithelialization without any discharge.

Comorbidities were recorded and categorized. Notably, one patient had a concurrent diagnosis of hidradenitis suppurativa and Behçet's disease, both of which are inflammatory conditions known to potentially affect wound healing and surgical outcomes

Surgical Technique

All procedures are performed under general anesthesia with the patient in the prone jackknife position, and the buttocks gently retracted with adhesive tape. The surgical site is shaved preoperatively and prepared with 10% povidone-iodine. Prophylactic intravenous metronidazole (500 mg) is administered 30 minutes before incision. Methylene blue (1–2 mL) is injected through the sinus openings to delineate the tracts.

The diseased tissue is excised en bloc as a longitudinal rectangle (Fig. 1a). A key design principle is that both the superior and inferior borders of this rectangle are placed at least 2 cm lateral to the midline. The medial border lies just lateral to the midline pits, and the lateral border extends down to the gluteal fascia.

A fasciocutaneous flap, including skin, subcutaneous fat, and gluteal fascia, is designed on the adjacent gluteal region (Fig. 1b). To allow a tension-free medial advancement, the flap's length is planned to be

approximately 1.5 times the length of the defect. The flap is raised from lateral to medial, with meticulous preservation of the perforating vessels.

The flap is then advanced directly medially into the rectangular defect like a bridge stone. As both the defect and flap are rectangular, they interdigitate perfectly, creating a straight-line closure without any acute angles at the midline (Fig. 1c). After inseting the flap, any lateral "dog-ear" deformity is excised. A layered closure is performed: the fascia is approximated with interrupted 2 – 0 polyglactin sutures, followed by two subcutaneous layers, and the skin is closed with a 3 – 0 polyglactin continuous subcuticular suture (Fig. 1d). The final result is a suture line where all corners are positioned more than 2 cm away from the midline, with no angulation at the natal cleft. A closed-suction drain is placed via a separate lateral stab incision.

Postoperative Care

Patients are mobilized on the first postoperative day, advised to avoid direct sitting for two weeks, and to maintain meticulous local hygiene. Follow-up visits are scheduled at 1 week, 2 weeks, 1 month, 3 months, 6 months, and annually thereafter.

Statistical Analysis

Statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were tested for normality using the Shapiro–Wilk test. As the data were not normally distributed, continuous variables are presented as median with interquartile range (IQR), and categorical variables are presented as frequencies and percentages. Comparisons between independent groups were performed using the Mann–Whitney U test for continuous variables. For categorical variables, Fisher's exact test was used when expected cell frequencies were less than 5; otherwise, the chi-square test was applied. Correlation analysis between continuous variables was performed using Spearman's rank correlation coefficient (ρ). Recurrence-free survival was estimated using the Kaplan–Meier method, and the 5 % confidence interval (CI) was calculated. A two-tailed p-value of less than 0.05 was considered statistically significant. Given the exploratory nature of this preliminary study and the small sample size, no adjustment for multiple comparisons was applied.

RESULT

Patient demographics and clinical characteristics

A total of 26 patients (24 male, 2 female) with recurrent pilonidal sinus disease were included in this study. The median age was 25.0 years (IQR: 20.0–26.0). The median body mass index (BMI) was 26.5 kg/m² (25.0–28.0), with 7 patients (26.9%) classified as obese (BMI $\geq$ 30). Four patients (15.4%) were active smokers. Comorbidities were present in four patients (15.4%). One patient had concurrent

hidradenitis suppurativa (HS) and Behçet's disease, and three other patients had other comorbidities (diabetes mellitus, etc.).

All patients had recurrent disease. The median number of previous surgical procedures was 2 (1–2). Previous interventions included lay open (n = 15, 57.7%), multiple phenol injection (n = 13, 50%), primary midline closure (n = 7, 26.9%), Flap procedures (n = 7, 26.9%), and curettage and laser surgery (n = 3, 11.5%). Sinus localization was lateral in 20 patients (76.9%) and midline in 6 patients (23.1%). The median number of sinus pits was 3 (2–4).

Demographic and clinical characteristics are summarized in Table 1.

Table 1
Demographic and clinical characteristics of the study population (n = 26)

Variable	n (%) or median (IQR)
Age (years)	25.0 (20.0–26.0)
Sex (M/F)	24 (92.3) / 2 (7.7)
BMI (kg/m ²)	26.5 (25.0–28.0)
Obesity (BMI ≥ 30)	7 (26.9)
Smoking	4 (15.4)
Comorbidity	4 (15.4)
Sinus localization	
• Midline	6 (23.1)
• Lateral	20 (76.9)
Number of pits	3 (2–4)
Number of previous surgeries	2(1–2)
Previous surgical procedures*	
• Lay open	15 (57.7)
• Multiple Phenol injection	13 (50)
• Flap procedures	7(26.9)
• Primary midline closure	7(26.9)
• Curettage and Laser Surgery	3 (11.5)
*Some patients had more than one previous procedure; therefore, percentages sum to more than 100%.	

Operative outcomes

The median operative time was 45 minutes (40–50). The median length of hospital stay was 1 day (1–2). All patients were mobilized on the first or second postoperative day (median: 1 day). The median VAS pain score on postoperative day 1 was 4 (3–5).

The median time to complete wound healing was 14 days (10–20). When analyzed by obesity status, obese patients (BMI $\geq$ 30) had a longer median healing time compared to non-obese patients (16 days vs. 13 days); however, this difference was not statistically significant ($p = 0.182$). Similarly, smokers had longer healing times than non-smokers (18 days vs. 14 days), but the difference did not reach statistical significance ($p = 0.234$).

Postoperative complications

Postoperative complications occurred in 5 patients (19.2%). The distribution of complications is shown in Table 2. The most common complication was seroma ($n = 2$, 7.7%) and flap edema ($n = 2$, 7.7%). Wound infection (surgical site infection) occurred in one patient who had concurrent HS and Behcet's disease (3.8%). No patient developed hematoma or wound dehiscence or flap necrosis. All complications were managed conservatively without the need for reoperation.

Table 2
Postoperative complications ($n = 26$)

Complication	n (%)
Any complication	5(19.2)
• Seroma	2 (7.7)
• Flap edema	2 (7.7)
• Wound infection (SSI)	1 (3.8)
• Partial wound dehiscence	0
• Hematoma	0
• Flap necrosis	0

Table 3
Summary of operative and postoperative outcomes
(n = 26)

Outcome	Median (IQR)
Operative time (min)	45 (40–50)
Hospital stay (days)	1 (1–2)
Time to first mobilization (days)	1 (1–1)
VAS pain score (POD 1)	4 (3–5)
Time to complete healing (days)	14 (10–20)
Follow-up (months)	28 (13–35)
Recurrence, n (%)	1 (3.8)
Patient satisfaction (1–10)	9 (8–9)
<i>POD, postoperative day; VAS, visual analog scale.</i>	

When comparing patients with and without complications, no significant differences were found in age (24.5 vs. 25.0 years, $p = 0.834$), BMI (26.8 vs. 26.4 kg/m², $p = 0.721$), or operative time (47.5 vs. 45.0 min, $p = 0.458$). However, patients with complications had a significantly longer time to complete wound healing (18.0 vs. 13.5 days, $p = 0.038$)

Recurrence

At a median follow-up of 28 months (IQR: 13–35), only one patient (3.8%) developed recurrence. The recurrence occurred at 11 months postoperatively in a 19-year-old male patient who had concurrent hidradenitis suppurativa and Behcet's disease, and a history of four previous surgical procedures (multiple phenol injection, primary closure, curettage and laser ablation, and abscess drainage). The recurrence-free survival at 24 months was 96.2%.

Notable clinical characteristics of the patient who developed recurrence included young age with Behcet's disease (19 years), high number of previous surgeries ($n = 4$), high pit count (5), prolonged healing time (24 days), and low patient satisfaction score (4/10). No other patient in the cohort developed recurrence during the follow-up period.

Patient satisfaction

The median patient satisfaction score was 9 out of 10 (8–9). Patients without recurrence reported significantly higher satisfaction scores compared to those with recurrence (median 9.0 vs. 6.0, $p = 0.031$). There was a moderate negative correlation between time to complete healing and patient satisfaction (Spearman's $\rho = -0.412$, $p = 0.036$), indicating that longer healing times were associated with lower satisfaction.

No significant correlation was found between patient satisfaction and age ($\rho = 0.114$, $p = 0.578$), BMI ($\rho = -0.098$, $p = 0.632$), or VAS pain score ($\rho = -0.287$, $p = 0.154$).

DISCUSSION

In this study, we describe a novel rectangular transposition flap for the surgical management of recurrent pilonidal sinus disease (PSD) and report our preliminary results in a cohort of 26 patients. We refer to this technique as the 'bridge stone flap' to emphasize its function: like a bridge stone that distributes load laterally, our rectangular flap shifts tension away from the midline and eliminates corner-origin recurrence. The key findings are that the technique is safe and feasible, with a low major complication rate (no flap necrosis), a recurrence occurred in one patient only has more than one inflammatory diseases (HS and Behcet's), and high patient satisfaction (median 9/10). These results compare favorably with published outcomes for other flap techniques in recurrent PSD [3, 4].

The primary motivation for developing this rectangular flap was our clinical observation that recurrences after flap surgery almost invariably originate from flap corners, particularly those located on or near the midline. This observation is strongly supported by the literature. Kaplan et al. (2017) demonstrated that the distance between the distal scar and the midline is an independent risk factor for recurrence, with a critical cut-off value of 11 mm, and recommended a safe margin of at least 2 cm [5]. The modified Limberg flap (MLF) was a significant advancement because it lateralized the inferior corner of the rhomboid excision, moving it 1–2 cm away from the midline [6, 7]. A recent meta-analysis by Doll et al. (2025) confirmed that the MLF has a significantly lower 5-year recurrence rate (4.9%) compared to the classical Limberg flap (7.1%), and the absence of a caudal midline scar was identified as the key protective factor [8]. However, the MLF still leaves the superior corner on or near the midline, and the lateralized inferior corner creates an acute angle that can be a point of tension and potential ischemia [9]. Similarly, the Karydakakis flap, despite its off-midline closure, uses an ovoid excision that results in both the upper and lower ends of the suture line approximating the midline, which may explain why its recurrence rate remains similar to that of the classical Limberg flap in some comparative studies [10, 11]. A systematic review by Wiinblad et al. (2025) found no significant difference in recurrence between the Karydakakis and Limberg operations [11].

Our rectangular flap addresses these geometric limitations in three fundamental ways. First, all flap corners are placed at least 2 cm away from the midline – both superior and inferior – exceeding the critical distance proposed by Kaplan and eliminating the "corner-origin" recurrence mechanism entirely [5]. Second, the midline closure is a straight line without any acute angles, which distributes tension evenly along the suture line and avoids stress concentration at vulnerable points, unlike rhomboid flaps that create Y-junctions or angled suture lines. Third, the technique is geometrically simple and has a short learning curve, as the rectangular design requires no complex measurements, making it more accessible to general surgeons compared to rhomboid flaps [12].

The only recurrence in our series and the single wound infection occurred in the same patient, a 19-year-old male with concurrent hidradenitis suppurativa and Behcet's disease. This patient also had the highest number of previous surgeries ($n = 4$) and the longest healing time (24 days) in the cohort. Hidradenitis suppurativa and Behcet's disease are both chronic inflammatory disorders that can impair wound healing and increase susceptibility to surgical site infections [13, 14]. The coexistence of these conditions in a young patient with recurrent disease likely represents a particularly challenging subgroup. This case underscores that while our rectangular flap effectively addresses the mechanical and anatomical factors of recurrence, systemic inflammatory conditions remain important patient-related risk factors that may limit the success of any surgical technique. Future studies should evaluate the efficacy of flap techniques specifically in patients with inflammatory comorbidities.

Doll et al. (2025) reported 5-year recurrence rates of 4.9% for MLF and 7.1% for classical LF in mixed primary and recurrent disease [8]. Wiinblad et al. (2025), in a systematic review of 50 randomized trials including 5,762 patients, reported that flap operations significantly reduced recurrence compared to primary midline closure (OR 0.31; 95% CI, 0.19–0.51) and infection rates (OR 0.33; 95% CI, 0.23–0.48) [11]. However, their meta-analysis found no significant difference in recurrence between the Limberg and Karydakakis flaps (OR 1.12; 95% CI, 0.66–1.89) [11]. This suggests that while off-midline flap techniques are superior to primary closure, the specific flap geometry may be less important than the principle of lateralizing the scar. Our bridge stone flap takes this principle one step further by completely eliminating all flap corners from the midline, a feature that is not achieved by either the Limberg (which retains a superior midline corner) or the Karydakakis (which has tapered ends approximating the midline) flaps. The favorable outcomes of our series support the hypothesis that the complete elimination of midline corners may offer an additional advantage over existing flap designs, although this needs to be confirmed in larger comparative trials.

Only one patient had recurrence in our series, who has important inflammatory diseases mentioned above. Noteworthy given that all patients in our series had recurrent disease, a higher-risk population. The only recurrence in our series occurred in a 19-year-old patient with Behcet's disease and four previous surgical procedures, suggesting that a history of multiple prior operations and underlying inflammatory conditions may be risk factors for recurrence even after flap salvage.

The overall complication rate in our series (19.2%) is within the range reported for other flap techniques (4.7% to 40%) [4, 8, 9]. Notably, we observed no flap necrosis or hematoma, which can be attributed to the rectangular flap design that preserves perforating vessels and avoids acute-angle ischemia. The median healing time of 14 days is comparable to or shorter than that reported for other flaps [6, 7, 9]. The one wound infection occurred in a patient with Behcet's disease, an inflammatory condition known to impair wound healing, suggesting that patient selection and comorbidity management remain important considerations.

Minimally invasive techniques (MIT), such as laser ablation and endoscopic sinus treatment, have gained popularity in recent years due to reduced postoperative pain and faster return to work [1]. Darnis

et al. (2025), in their comprehensive review, reported that MITs are associated with lower complication rates but at the cost of a higher recurrence rate (approximately 24% at 5 years for endoscopic treatment) [1]. A meta-analysis by Bi et al. (2020) confirmed that MITs have lower complication rates but a comparatively high recurrence rate [2]. In contrast, our flap technique offers a definitive solution with a low recurrence rate, albeit with a slightly higher complication profile. The choice between MIT and flap surgery should be individualized based on disease severity, patient preference, and surgeon expertise.

This study has several limitations that must be acknowledged. First, it is a retrospective, single-arm case series with a relatively small sample size ($n = 26$). The lack of a control group precludes direct comparison with other flap techniques. Second, the follow-up period (median 28 months) may not be sufficient to capture late recurrences, as some studies have reported recurrences occurring up to 5–10 years after surgery [8, 11, 15]. Third, the single recurrence event in our series limited our ability to perform meaningful subgroup analyses to identify risk factors for recurrence. Fourth, patient-reported outcomes such as quality of life and cosmetic satisfaction were assessed using a simple 1–10 scale rather than validated instruments. Fifth, the study was conducted at a single center, which may limit the generalizability of our findings. Future prospective, comparative trials with larger sample sizes, longer follow-up periods (minimum 5 years), and validated patient-reported outcome measures are warranted to confirm the superiority of the rectangular flap over existing techniques.

Despite these limitations, this study has several strengths. First, it is the first report of a rectangular advancement flap specifically designed to eliminate all midline corners. Second, the study includes a homogeneous cohort of patients with recurrent disease, a challenging population that is often excluded from primary PSD trials. Third, the median follow-up of 28 months exceeds the minimum 12-month follow-up recommended for PSD recurrence assessment [15]. Fourth, the absence of loss to follow-up strengthens the reliability of recurrence estimates.

CONCLUSION

The rectangular advancement flap (bridge stone flap) is a novel and effective surgical technique for the management of recurrent pilonidal sinus disease. By relocating all flap corners at least 2 cm away from the midline and achieving a straight-line midline closure, it directly addresses the biomechanical principles underlying corner-origin recurrence – a concept strongly supported by the literature [5, 8]. Our preliminary results demonstrate that the technique is safe (no flap necrosis or hematoma), associated with acceptable morbidity (complication rate 19.2%), and yields a low recurrence rate (3.8% at 28 months) in a challenging patient population with recurrent disease. The technique is simple, has a short learning curve, and avoids the geometric drawbacks of rhomboid and ovoid flaps. These encouraging preliminary findings warrant further evaluation in larger, prospective, comparative studies with extended follow-up.

Declarations

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Author Contribution

Tahsin Colak: Designed the study, performed the surgeries, analyzed the data, and drafted the manuscript. Cumhuri Ozcan: Contributed to data collection, statistical analysis, and manuscript revision. Both authors read and approved the final manuscript.

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Figures

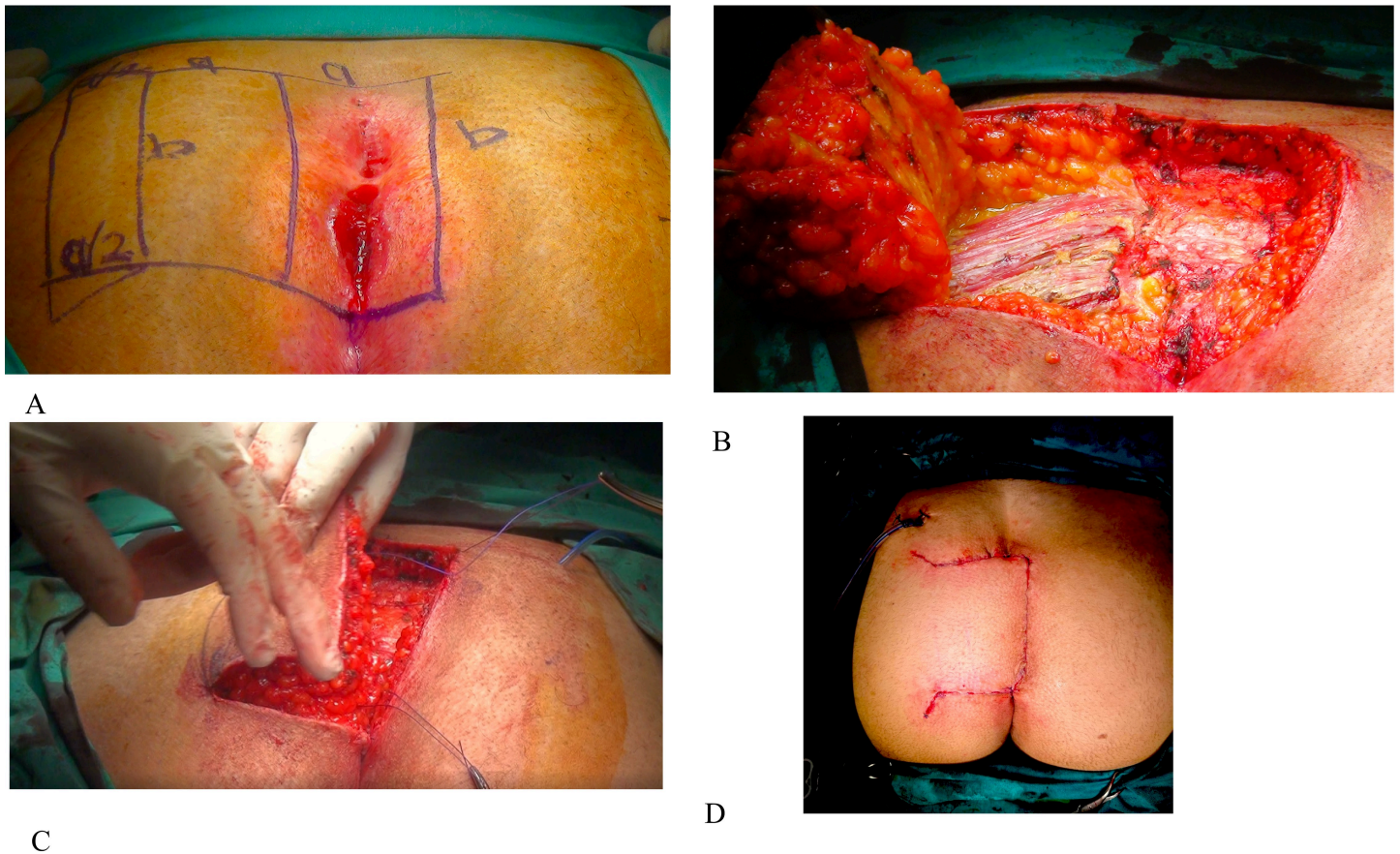


Figure 1

Intraoperative photographs of the rectangular advancement flap technique. **a** Preoperative skin marking of the rectangular excision. Note that both the superior and inferior borders are placed at least 2 cm lateral to the midline. **b** The fasciocutaneous flap is raised from the gluteal region. The flap includes skin, subcutaneous fat, and the underlying gluteal fascia. **c** The flap is advanced medially and the fascia is approximated to the recipient site with interrupted sutures. **d** Final appearance after skin closure. The midline closure is straight without any angulation, and all corners are positioned away from the midline.

