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Comparison of V-Y Advancement Flap with Reverse Sural Flap for Coverage of Posterior Heel Soft Tissue Defects

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ABSTRACT

Background: Soft tissue defects of the posterior heel are difficult to manage due to high pressure load, limited local tissue, and frequent exposure of vital structures. **Objective:** To compare the outcomes of V-Y advancement flap and reverse sural flap for coverage of posterior heel soft tissue defects. **Methodology:** This randomized controlled trial was conducted at the Department of Plastic Surgery, Shaikh Zayed Hospital, Lahore, from November 2024 to April 2025. Sixty patients aged 14–60 years with posterior heel soft tissue defects were enrolled and randomized into two groups (n=30 each). Group A underwent reverse sural flap, while Group B received V-Y advancement flap. **Results:** The mean operative time was significantly longer in Group A (96.2 ± 14.8 min) compared to Group B (72.5 ± 11.3 min; $p < 0.001$). Flap necrosis occurred in 5 patients (16.7%) in Group A versus 1 patient (3.3%) in Group B ($p = 0.04$). Donor site disfigurement was observed in 20.0% of Group A patients but in none of Group B ($p = 0.01$). Other complications such as flap dehiscence, edema, congestion, and infection were more frequent in Group A but not statistically significant. By day 14, satisfactory wound healing was achieved in 86.7% of Group A and 96.7% of Group B patients ($p = 0.16$). **Conclusion:** Both flaps are effective for posterior heel reconstruction. The V-Y advancement flap offers shorter operative time, lower necrosis rates, and superior donor site cosmesis, making it preferable for small to moderate defects. The reverse sural flap remains valuable for larger or more complex heal wounds.

INTRODUCTION

Soft tissue defects of the posterior heel represent a significant reconstructive challenge in plastic and orthopedic surgery due to the unique anatomical and functional characteristics of this region. The heel bears high pressure and shear forces during ambulation, and its limited soft tissue envelope makes primary closure difficult in cases of trauma, infection, or tumor resection [1]. Exposed calcaneus or Achilles tendon further complicates management, as inadequate coverage can lead to chronic ulceration, infection, and loss of function. Therefore, durable, sensate, and stable coverage is essential for optimal functional recovery. Various reconstructive options have been described for posterior heel defects, ranging from skin grafting to local, regional, and free flaps [2]. Skin grafts are generally unsuitable due to poor durability in weight-bearing areas. Free flaps, though versatile, require microsurgical expertise and prolonged operative time, limiting their feasibility in resource-constrained settings. As a result, local and regional flaps remain the mainstay of treatment for posterior heel coverage [3].

The heel is a vital and complex structure that plays a crucial role in weight-bearing and mobility [4]. Plastic surgeons frequently encounter soft tissue defects in the heel region, resulting from various causes such as traumatic injury mostly wheel spoke injury, burns, tumor resections, pressure necrosis and ulcers [5]. Even small skin defects in this area can be difficult to heal especially the area where the posterior and planter heel meet is prone to pressure sores and trauma resulting in soft tissue defects and represent challenges for plastic surgeons, especially when vital structures are exposed [6,7]. Early coverage is an emergency, when underlying important vital structure are exposed. For this, various reconstructive methods have been described depending upon the depth, size and site of the defect e.g; skin grafts, local skin flaps, muscle flaps, dorsalis pedis flap, lateral calcaneal artery flap, distally based and reverse pedicled fasciocutaneous flapsfrom the lower legalong with neurovascular free flaps, harvested distant site from the same body [8]. Microvascular free flaps require specialized expertise and equipment, availability of appropriate recipient arteries and veins for anastomosis, and there is

relatively prolonged operating time and may result in bulkiness and poor cosmesis [9,10].

Recently,the V-Y advancement flap has gained attention for its potential in reconstructing defects in the posterior heel area for small to medium size defects, where underlying tendoachillies or calcanium is exposed offering a promising solution that preserves major blood vessels and allows for quick elevation and insertion into the defect which otherwise needs time for bed preparation along with risk of exposed tissue necrosis and infection [11]. Among these, the V-Y advancement flap and the reverse sural flap are widely utilized. The V-Y advancement flap, based on local tissue recruitment, offers the advantages of a relatively simple technique, preservation of major vascular structures, and good color and texture match. However, its utility is restricted too small to moderate defects, and tension at the suture line may compromise outcomes in larger wounds [12]. The reverse sural flap, on the other hand, is a fasciocutaneous flap based on the sural nerve and accompanying vascular plexus. It allows coverage of larger posterior heel defects without microsurgery, though drawbacks include donor site morbidity, venous congestion, and potential sensory loss [13].

To address this, it's essential to choose a robust flap for reconstruction, particularly for small to moderate-sized defects in the posterior heel area, to ensure effective coverage and minimize donor-site complications [14,15]. Previous study on reverse sural fascio-cutaneous flap outcomes showed six 6 flap Necrosis among 16 patients i.e; 37.5%.[9] while in a study of V-Y advancement this rate was recorded in 1 patient out of 22 only 4.5% in V-Y advancement flap [16]. Another comparative study of V-Y advancement flap and reverse sural artery flap on coverage of soft-tissue defects in the heel, suggested that among locoregional flaps, the V-Y advancement flap is an effective method for reconstructing small to intermediate size defects in the posterior heel area due to its minimal donor site morbidity, similar tissue to heel and help in preserving protective sensation [17].

Objective

This study compares the outcomes of two surgical techniques, V-Y advancement flaps and reverse sural flaps,intreating small to moderate size, soft tissue defect of posterior heel traumapatients.

METHODOLOGY

This randomized controlled trial was conducted at the Department of Plastic Surgery, Shaikh Zayed Hospital, Lahore, from November 2024 to April 2025. A total of 60 patients were included, with 30 allocated to each group. The sample size was calculated at a 95% confidence level, 80% power, with an expected necrosis rate of 37.5% in reverse sural flap and 4.5% in V-Y advancement flap [10]. Non-probability consecutive sampling was employed to collect the data.

Inclusion Criteria

- Patients aged 14–60 years
- Either gender
- Patients presenting with soft tissue defects involving the posterior heel

Exclusion Criteria

- Graftable wound with intact paratenon
- Old wounds with established granulation tissue
- Patients with uncontrolled diabetes (RBS >200 mg/dl on medical records)
- Trauma compromising blood supply of the donor site for reverse sural flap
- Patients unwilling to undergo the procedure

Data Collection

Following approval from the institutional ethical review committee, patients meeting the inclusion criteria were enrolled after obtaining informed consent. Demographic details including name, age, gender, hemoglobin levels (anemia defined as Hb <10 g/dl), diabetes status (RBS >200 mg/dl), wound size, and cause of trauma were recorded. Patients were randomized into two groups using the lottery method. Group A underwent reconstruction using reverse sural flap, while Group B received V-Y advancement flap. All procedures were performed under either general or spinal anesthesia by the same surgical team, and operative time was noted. Postoperatively, both flaps were monitored for ischemia, edema, and congestion at 24 and 72 hours in the ward. Patients were followed up in the outpatient department on day 7 for assessment of flap necrosis. Patients developing complications were managed according to standard clinical protocols. Data were recorded on a predesigned proforma.

Data Analysis

Data were analyzed using SPSS version 25. Quantitative variables such as age, wound size, and operative time were presented as mean ± standard deviation if normally distributed, or as median with interquartile range otherwise. Qualitative variables such as gender, flap necrosis, wound healing, and complications (flap ischemia, edema, congestion, infection, dehiscence, and donor site disfigurement) were expressed as frequencies and percentages. Intergroup comparisons were made using the chi-square test. A p-value ≤0.05 was considered statistically significant. Stratification was performed for age, gender, wound size, cause of trauma, anemia, and diabetes. Post-stratification, chi-square test was again applied to compare flap necrosis and donor site disfigurement between the two groups.

RESULTS

Data were collected from 60 patients, mean age of patients was 34.8 ± 10.7 years in the reverse sural flap group and 33.5 ± 9.8 years in the V-Y advancement flap group. Males predominated in both groups (70.0% vs. 66.7%). The mean wound size was similar (18.6 ± 4.2 cm^2 vs. 17.9 ± 3.8 cm^2). The distribution of comorbidities was also balanced, with anemia present in 16.7% of Group A and 13.3% of Group B, while diabetes was seen in 20.0% and 16.7% of patients, respectively. Road traffic accidents were the leading cause of trauma in both groups, followed by crush injuries and other mechanisms. No statistically significant differences were noted in baseline demographics or comorbidities ($p > 0.05$).

The mean operative time was significantly longer in the reverse sural flap group compared to the V-Y advancement flap group (96.2 ± 14.8 vs. 72.5 ± 11.3 minutes, $p < 0.001$).

Flap necrosis was more frequent with reverse sural flaps (16.7%) compared to V-Y flaps (3.3%), reaching statistical significance (p = 0.04). Flap dehiscence, edema/congestion, and infection were all slightly more common in Group A, though these differences were not statistically significant. Donor site disfigurement was observed in 20.0% of reverse sural flap cases but was absent in V-Y advancement flaps (p = 0.01). By day 14, satisfactory wound healing was achieved in 86.7% of Group A and 96.7% of Group B patients (p = 0.16).

Table 1

Baseline Characteristics of Patients (n = 60)

Variable	Group A: Reverse Sural Flap (n=30)	Group B: V-Y Advancement Flap (n=30)
Age (years), mean ± SD	34.8 ± 10.7	33.5 ± 9.8
Gender, n (%)		
– Male	21 (70.0%)	20 (66.7%)
– Female	9 (30.0%)	10 (33.3%)
Wound size (cm^2), mean ± SD	18.6 ± 4.2	17.9 ± 3.8
Anemia (Hb <10 g/dl), n (%)	5 (16.7%)	4 (13.3%)
Diabetes (RBS >200 mg/dl), n (%)	6 (20.0%)	5 (16.7%)
Cause of trauma, n (%)		
– Road traffic accident	14 (46.7%)	15 (50.0%)
– Crush injury	10 (33.3%)	9 (30.0%)
– Other	6 (20.0%)	6 (20.0%)

Table 2

Operative and Postoperative Outcomes

Outcome	Group A: Reverse Sural Flap (n=30)	Group B: V-Y Advancement Flap (n=30)	Test statistic	p-value
Operative time (minutes), mean ± SD	96.2 ± 14.8	72.5 ± 11.3	t = 6.38	<0.001*
Flap necrosis, n (%)	5 (16.7%)	1 (3.3%)	χ^2 = 4.08	0.04*
Flap dehiscence, n (%)	4 (13.3%)	2 (6.7%)	χ^2 = 0.55	0.38
Flap edema/congestion, n (%)	6 (20.0%)	2 (6.7%)	χ^2 = 2.34	0.13
Infection, n (%)	3 (10.0%)	2 (6.7%)	χ^2 = 0.22	0.64
Donor site disfigurement, n (%)	6 (20.0%)	0 (0.0%)	χ^2 = 6.67	0.01*
Satisfactory wound healing (Day 14), n (%)	26 (86.7%)	29 (96.7%)	χ^2 = 1.93	0.16

*p ≤ 0.05 considered statistically significant.

Among diabetic patients, necrosis occurred in 3 of 6 cases (50.0%) in Group A and 1 of 5 cases (20.0%) in Group B (p = 0.24). In non-diabetics, necrosis was seen in 2 of 24 (8.3%) in Group A and none of 25 in Group B (p = 0.08). Anemic patients showed necrosis in 2 of 5 (40.0%) in Group A and none of 4 in Group B (p = 0.14), while in non-anemic patients, necrosis occurred in 3 of 25 (12.0%) in Group A and 1 of 26 (3.8%) in Group B (p = 0.19). No necrosis occurred in patients with wounds ≤15 cm^2, whereas for wounds >15 cm^2, necrosis was seen in 5 of 20 patients (25.0%) in Group A and 1 of 20 patients (5.0%) in Group B (p = 0.08).

Table 3

Stratification of Flap Necrosis by Risk Factors

Variable		Group A: Reverse Sural Flap (n=30)	Group B: V-Y Advancement Flap (n=30)	p-value
Diabetes	Present (n=11)	3/6 (50.0%)	1/5 (20.0%)	0.24
	Absent (n=49)	2/24 (8.3%)	0/25 (0.0%)	0.08
Anemia	Present (n=9)	2/5 (40.0%)	0/4 (0.0%)	0.14
	Absent (n=51)	3/25 (12.0%)	1/26 (3.8%)	0.19
Wound size	≤15 cm^2 (n=20)	0/10 (0.0%)	0/10 (0.0%)	—
	>15 cm^2 (n=40)	5/20 (25.0%)	1/20 (5.0%)	0.08

At 24 hours, flap ischemia was observed in 2 patients (3.3%), edema in 5 (8.3%), and congestion in 4 (6.7%). By 72 hours, ischemia increased to 3 cases (5.0%), edema to 6 (10.0%), and congestion to 5 (8.3%). At day 7, ischemia was seen in 2 cases (3.3%), edema in 3 (5.0%), congestion in 2 (3.3%), infection in 4 (6.7%), and flap dehiscence in 4 (6.7%). By day 14, ischemia persisted in 1 case (1.7%), edema in 1 (1.7%), infection in 5 (8.3%), and flap dehiscence in 6 (10.0%). Donor site disfigurement was first noted at day 7 in 6 patients (10.0%) and persisted at day 14 without change.

Table 4

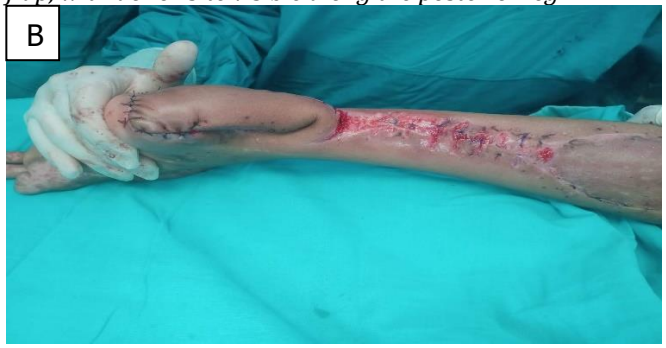
Postoperative Complications by Follow-Up Interval

Complication	24 Hours (n=60)	72 Hours (n=60)	Day 7 (n=60)	Day 14 (n=60)
Flap ischemia	2 (3.3%)	3 (5.0%)	2 (3.3%)	1 (1.7%)
Flap edema	5 (8.3%)	6 (10.0%)	3 (5.0%)	1 (1.7%)
Flap congestion	4 (6.7%)	5 (8.3%)	2 (3.3%)	0 (0.0%)
Infection	0 (0.0%)	1 (1.7%)	4 (6.7%)	5 (8.3%)
Flap dehiscence	—	—	4 (6.7%)	6 (10.0%)
Donor site disfigurement	—	—	6 (10.0%)	6 (10.0%)

Figure 1

Intraoperative and postoperative outcomes of reverse sural flap for posterior heel reconstruction. **(A)** *Postoperative view showing a well-settled flap with intact sutures and adequate defect coverage.*

(B) *Intraoperative elevation and inset of the reverse sural flap, with donor site visible along the posterior leg.*



(C) *Depicts a wound site with exposed tissue, possibly indicating early granulation or complications in flap healing.*

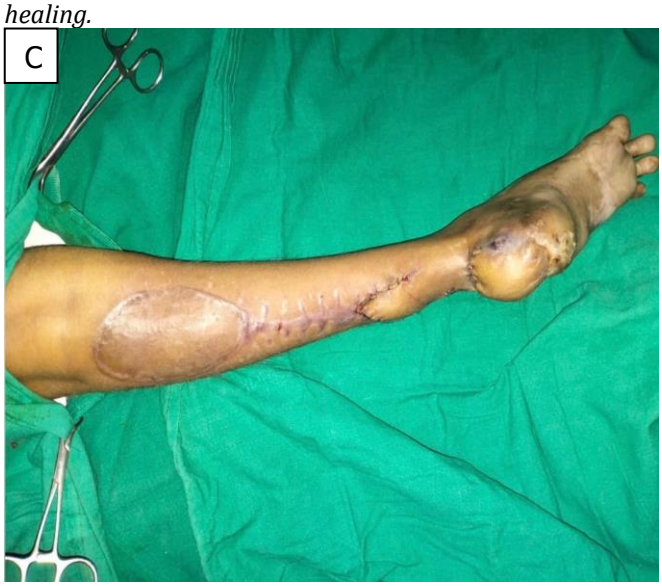
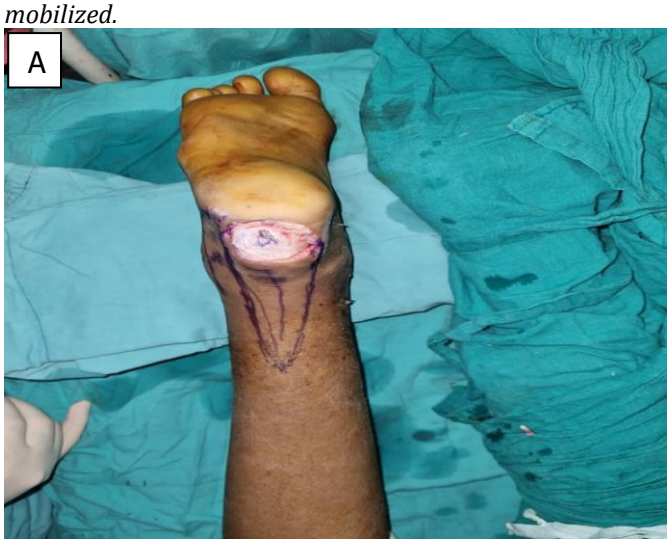
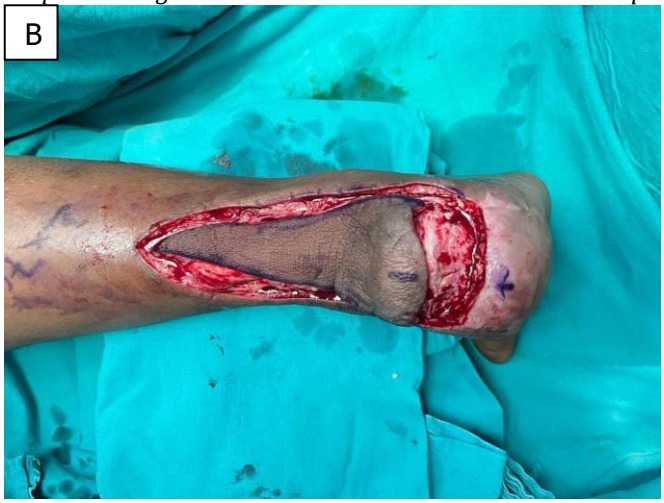


Figure 2

(A) *The initial stage shows the area being prepared for the V-Y advancement flap. The "V" shaped incision is likely marked out or partially created, ready for the flap to be mobilized.*



(B) *This shows the flap being advanced. The tissue is being moved into place to cover the defect or wound, with the "V" shape being stretched into the "Y" shape.*



(C) *The final image shows the flap sutured in place, completing the wound closure. The "Y" shaped incision is now covered by the adjacent tissue, which will help in healing and may result in a less noticeable scar.*

DISCUSSION

Soft tissue coverage of the posterior heel remains a significant reconstructive challenge due to the region's unique anatomy, limited local tissue availability, and constant exposure to weight-bearing stresses. In this randomized controlled trial, we compared two commonly utilized techniques reverse sural flap and V-Y advancement flap in terms of operative outcomes, complication rates, and early functional recovery. Our findings indicate that while both techniques are effective, the V-Y advancement flap demonstrated shorter operative times, lower necrosis rates, and fewer donor site complications compared to the reverse sural flap. The mean operative time was significantly longer in the reverse sural flap group compared to the V-Y advancement group, consistent with previous studies reporting that harvesting and insetting of fasciocutaneous flaps such as the reverse sural flap generally require more technical steps than local advancement flaps. Similar findings were described by Parrett et al., who emphasized the relative simplicity and efficiency of local flaps for smaller heel defects [18]. This makes the V-Y advancement flap particularly attractive in resource-limited centers where operative efficiency is essential. In terms of flap survival, necrosis was observed more frequently in the reverse sural flap group (16.7%) compared to the V-Y advancement group (3.3%). This aligns with earlier reports highlighting the vulnerability of the reverse sural flap to venous congestion and distal necrosis due to its reliance on retrograde flow [19]. Despite modifications in flap design and delay techniques proposed in the literature, venous compromise remains a recognized limitation of this flap. In contrast, the V-Y advancement flap, based on local tissue recruitment, maintains a robust vascularity and avoids long pedicles, accounting for its lower necrosis rates in this study. Complication rates also differed between groups. Flap dehiscence and edema were more frequent in the reverse sural flap group, though differences did not reach statistical significance. Importantly, donor site disfigurement was seen exclusively in the reverse sural flap group (20.0%), highlighting a drawback often noted in the literature [20]. Several authors, including Masquelet and Gilbert, have

reported on donor site morbidity and sensory loss due to sacrifice of the sural nerve. Conversely, the V-Y advancement flap preserves donor site integrity, providing a cosmetic and functional advantage, especially in younger patients or those with aesthetic concerns. Our stratified analysis suggested that risk factors such as diabetes, anemia, and larger wound size increased the likelihood of necrosis, particularly in patients undergoing reverse sural flap reconstruction [21]. These findings underscore the importance of patient selection and risk optimization before flap surgery. Previous reports have similarly noted higher complication rates in diabetic patients and those with compromised vascularity, recommending careful intraoperative and postoperative monitoring in such cases. From a functional perspective, both techniques ultimately achieved satisfactory wound healing by day 14 in the majority of patients. However, the slightly higher proportion of complete wound healing in the V-Y advancement flap group suggests that for smaller to moderate posterior heel defects, this technique may offer superior reliability with fewer complications. The reverse sural flap, while more versatile in covering larger defects, should be reserved for situations where local tissue options are inadequate.

Limitations

This study has certain limitations. The sample size was modest, which may have limited the statistical power to detect differences in less frequent complications. The follow-up duration was short (14 days), and longer-term outcomes such as flap durability under full weight-bearing and patient-reported functional scores were not assessed. Moreover, as this was a single-center trial, the results may not be generalizable to all clinical settings.

CONCLUSION

It is concluded that both the V-Y advancement flap and the reverse sural flap provide reliable options for coverage of posterior heel soft tissue defects. However, the V-Y advancement flap demonstrated shorter operative time, lower rates of flap necrosis, and no donor site disfigurement, making it a more favorable option for small to moderate-sized defects. The reverse sural flap, while associated with higher complication rates, remains a valuable technique for larger or complex heel wounds where local advancement flaps are not feasible. Careful patient selection and individualized flap choice are therefore essential to optimize reconstructive outcomes.

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