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Posterior Tibial Artery Pedicled Perforator Flaps for Reconstruction of Soft Tissue Defects of the Leg and Ankle: A Descriptive Cross-sectional Study

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Abstract

Background: Distal leg and ankle defects are challenging to reconstruct because of limited local tissue availability and regional vascularity. Posterior tibial artery pedicled perforator flaps provide vascularized coverage while preserving the main arterial axis.
Methods: This prospective case series included 12 consecutive patients undergoing posterior tibial artery pedicled perforator flap reconstruction between January 2022 and December 2024. Patient characteristics, defect details, operative outcomes, complications, flap survival, and functional recovery were assessed.
Results: The mean age was 36.8 years (range, 18–62), and trauma accounted for 75% of defects. Complete flap survival occurred in 11 patients (91.7%). One patient developed partial distal necrosis involving less than 15% of the flap, which healed with conservative dressings. Early venous congestion occurred in two patients and resolved with limb elevation and suture release. No total flap loss occurred.
Conclusion: Posterior tibial artery pedicled perforator flaps are a feasible option for selected distal leg and ankle defects. Accurate perforator localization, tension-free inset, appropriate patient selection, and close postoperative monitoring are essential.

Keywords: Perforator flap; lower limb reconstruction; pedicled flap; propeller flap.

Introduction

Reconstruction of soft tissue defects of the distal third of the leg remains difficult because of limited local tissue availability, reduced soft tissue mobility, and frequent exposure of bone, tendon, or implants.[1] Trauma, chronic osteomyelitis, implant exposure, and chronic ulceration commonly require durable and well-vascularized soft tissue coverage in this anatomical region.

Free tissue transfer is widely regarded as a dependable option for complex lower extremity reconstruction as it provides versatile tissue replacement.[2] However, free flaps require microsurgical expertise, longer operative time, specialized postoperative monitoring, and may increase donor-site morbidity.[3] These considerations are especially relevant in centers with limited microsurgical resources or in patients who are not ideal candidates for lengthy procedures.

Perforator flap surgery has expanded local reconstructive options by allowing transfer of vascularized skin and subcutaneous tissue based on isolated cutaneous perforators while sparing muscle and preserving major

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vascular trunks.[4] Posterior tibial artery perforator flaps are based on septocutaneous perforators arising from the posterior tibial artery and provide thin, pliable tissue suitable for coverage of the distal leg, ankle, heel, and tendoachilles region.[5]

The reliability of these flaps depends on accurate perforator identification, preservation of the perforator pedicle during dissection, avoidance of excessive torsion during rotation, and careful postoperative monitoring. Despite encouraging results from previous studies, there is a paucity of published data on the use of posterior tibial artery pedicled perforator flaps from Nepal. Given the limited regional evidence, this prospective case series was conducted to evaluate the feasibility and outcomes of this technique in our geographical setting.

Methods

Study Design and Setting

This prospective observational case series was conducted at the Department of Orthopaedic Surgery, B & B Hospital, Nepal, between January 2022 and December 2024 after obtaining approval from the Institutional Review Board .Written informed consent was obtained from all participants for surgery, clinical photography, and publication. A total of 12 consecutive patients fulfilling the eligibility criteria were enrolled during the study period. As this was an observational case series, no formal sample size calculation was performed; instead, all consecutive eligible patients presenting during the study period were included to minimize selection bias.

Patient Selection

Patients with soft tissue defects of the distal third of the leg, ankle, heel, or tendo-Achilles region requiring vascularized soft tissue coverage were considered for posterior tibial artery pedicled perforator flap reconstruction. Patients were included if they had exposure of bone, tendon, joint, or implant, clinically palpable distal pulses or satisfactory vascular assessment, and an identifiable posterior tibial artery perforator on handheld Doppler examination. Patients with severe peripheral vascular disease, absent distal pulses, extensive crush injury or scarring within the anticipated perforator zone, uncontrolled diabetes mellitus or other significant systemic comorbidities, generalized sepsis, or those deemed medically unfit for flap surgery were excluded.

Preoperative Assessment

All patients underwent detailed clinical evaluation, wound assessment, and plain radiographic examination. Vascularity of the affected limb was assessed clinically by palpation of distal pulses and confirmed using a handheld Doppler device. Posterior tibial artery perforators were mapped along the line joining the medial malleolus and the medial tibial condyle, with particular attention to perforators located approximately 5–12 cm proximal to the medial malleolus. Defect dimensions were measured after definitive debridement to accurately determine the required flap size.

Surgical Technique

All procedures were performed under spinal or general anesthesia with the patient in the supine position and the affected limb externally rotated. Following meticulous wound debridement, flap dimensions were designed according to the final defect size while allowing a small margin for tension-free inset. The dominant perforator was selected based on handheld Doppler localization and intraoperative confirmation of its caliber and pulsatility. Subfascial flap elevation was performed carefully, and the perforator pedicle was dissected only to the extent necessary to permit flap rotation without undue tension.

The flap was islanded and rotated as a propeller flap to cover the defect while avoiding excessive torsion, compression, or kinking of the perforator pedicle. After confirming adequate flap perfusion, the flap was inset without tension, taking care to avoid compression over the pedicle. Donor sites were reconstructed with split-thickness skin grafting in all patients.

Intraoperative Assessment

The intraoperative variables recorded included the anatomical location of the defect, defect size after definitive debridement, flap dimensions, flap rotation angle, distance of the selected perforator from the tip of the medial malleolus, and pedicle length after dissection.

These parameters were documented prospectively using a standardized data collection sheet and analyzed descriptively.

Postoperative Management

The operated limb was maintained in an elevated position during the early postoperative period, and dependent positioning was avoided. Flaps were monitored regularly for colour, temperature, capillary refill, and evidence of venous congestion. Intravenous antibiotics were administered according to the degree of wound contamination and institutional protocol. Regular wound dressings were performed, and mobilization was initiated after flap stabilization. When early venous congestion was detected, conservative measures including limb elevation and loosening of tight sutures were undertaken.

Outcome Measures

The primary outcome measure was flap survival. Secondary outcomes included the incidence of venous congestion, partial flap necrosis, total flap loss, donor-site morbidity, cosmetic acceptability, and the requirement for secondary procedures. Clinical outcomes were assessed during the inpatient period and at subsequent follow-up visits, and all data

were recorded prospectively using a predefined outcome assessment form.

Results

A total of 12 consecutive patients underwent posterior tibial artery pedicled perforator flap reconstruction during the study period. The mean age was 36.8 years (range, 18–62 years), with a male predominance (9 males and 3 females). The mean follow-up duration was 8 months. The baseline demographic and clinical characteristics of the study population are summarized in Table 1.

The most common indication for reconstruction was post-traumatic soft tissue loss following road traffic accidents (58.3%), followed by implant exposure (16.7%), chronic osteomyelitis (16.7%), and chronic ulceration (8.3%). The etiological distribution of soft tissue defects is presented in Table 2.

The intraoperative characteristics of the defects and flaps are shown in Table 3. The mean defect size was 7.1 × 8.4 cm (range, 4 × 5 to 10 × 14 cm), whereas the mean flap size was 8.4 × 10.0 cm (range, 5 × 6 to 12 × 15 cm). The mean flap rotation angle was 142° (range, 90°–180°). The selected perforator was located at a mean distance of 8.1 cm from the medial malleolus (range, 5–12 cm), and the mean pedicle length after dissection was 3.4 cm (range, 2.5–5 cm).

Complete flap survival was achieved in 11 of the 12 patients (91.7%). One patient developed partial distal flap necrosis involving less than 15% of the flap surface area, which healed with conservative wound care and did not require further reconstructive surgery. Early venous congestion occurred in two patients and resolved following limb elevation and loosening of tight sutures. No patient experienced total flap loss. All donor sites were reconstructed with split-thickness skin grafting. Flap-related outcomes are summarized in Table 4.

Discussion

Soft tissue reconstruction of the distal leg is challenging because of poor regional vascularity, limited local tissue laxity, and frequent exposure of functionally important structures.[1] Several reconstructive methods have been described, including cross-leg flaps, muscle flaps, fasciocutaneous flaps, perforator flaps, and free tissue transfer.[2]

Posterior tibial artery pedicled perforator flaps are useful because they provide local tissue with good color and texture match while preserving the major vascular axis. In the present series, complete flap survival was achieved in 91.7% of patients, which is consistent with previously reported survival rates of approximately 88%-98% in lower limb perforator flap series.[6,7]

Venous congestion is one of the most important complications in propeller perforator flaps and is usually related to pedicle twisting, tension, or compression after rotation.[8] In this series, early venous congestion occurred

Table 1. Demographic and Clinical Characteristics

Variable	Value
Number of patients	12
Mean age (years)	36.8
Age range (years)	18–62
Male : Female	9 : 3
Mean follow-up	8 months

Table 2. Etiology of soft tissue defects

Etiology	n (%)
Road traffic accident	7 (58.3)
Implant exposure	2 (16.7)
Chronic osteomyelitis	2 (16.7)
Chronic ulcer	1 (8.3)

Table 3. Intraoperative characteristics

Variable	Value
Mean defect size	7.1 × 8.4 cm
Defect size range	4 × 5–10 × 14 cm
Mean flap size	8.4 × 10.0 cm
Flap size range	5 × 6–12 × 15 cm
Mean flap rotation angle	142°
Rotation angle range	90°–180°
Mean perforator distance	8.1 cm
Perforator distance range	5–12 cm
Mean pedicle length	3.4 cm
Pedicle length range	2.5–5 cm

Table 4. Clinical outcomes

Outcome	Value
Complete flap survival	11 (91.7%)
Partial flap necrosis	1 (8.3%)
Venous congestion	2 (16.7%)
Total flap loss	0
Primary donor-site closure	0
Split-thickness skin graft	12 (100%)



Figure 1 Posterior tibial artery pedicled perforator flap reconstruction for a post-traumatic distal medial leg defect. (A) Preoperative photograph demonstrating a 6 × 8 cm soft tissue defect over the distal medial leg with exposed medial malleolus following a road traffic accident. (B) Immediate postoperative photograph showing coverage of the defect using a posterior tibial artery pedicled perforator flap based on a perforator located 7 cm proximal to the medial malleolus. (C) Clinical photograph at 4 weeks demonstrating complete flap survival and satisfactory wound healing.

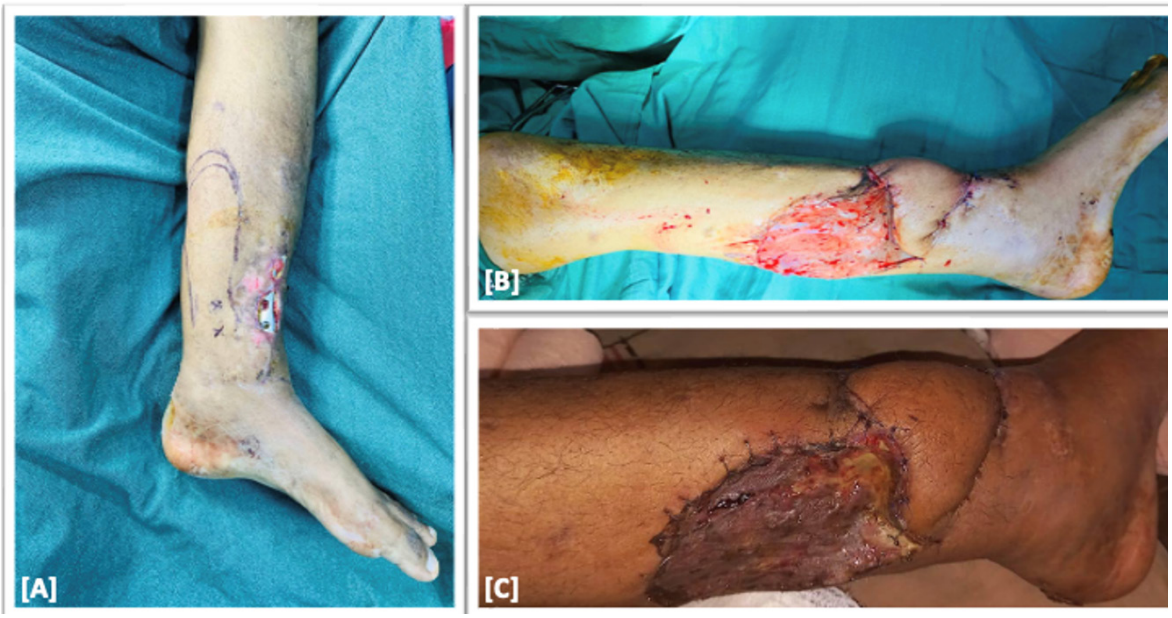


Figure 2 Posterior tibial artery pedicled perforator flap reconstruction for implant exposure after tibial fracture fixation. (A) Preoperative photograph demonstrating distal tibial implant exposure following previous tibial fracture fixation. (B) Immediate postoperative photograph after coverage of the defect using a posterior tibial artery pedicled perforator flap following serial debridement and wound optimization. (C) Clinical photograph at two weeks demonstrating a viable flap with resolution of mild postoperative venous congestion after conservative management.

in two patients and resolved with conservative measures, emphasizing the value of frequent monitoring and early intervention.

Reconstruction of distal leg and ankle soft tissue defects remains challenging because of limited local tissue availability, poor vascularity, and frequent exposure of bone, tendon, or orthopedic implants. [9] Posterior tibial artery perforator flaps have become increasingly popular because they provide well-vascularized local tissue while preserving the major arterial axis and avoiding the need for microsurgical free tissue transfer.[10] In the present prospective case series, complete flap survival was achieved in 91.7% of patients, with only one case of partial distal flap necrosis and two cases of transient venous congestion that resolved with conservative management. These findings suggest that posterior tibial artery pedicled perforator flaps are a reliable reconstructive option for carefully selected distal leg and ankle defects.

Our findings are consistent with the recent clinical study by Gao M et al., who evaluated posterior tibial artery perforator-based fasciocutaneous flaps with a broad fascial pedicle in 15 patients with complex lower-leg wounds. They reported complete flap survival in all patients without partial or total necrosis, minimal donor-site morbidity, preservation of ankle motion, and independent ambulation at follow-up. [11]Although our flap survival rate (91.7%) was slightly lower because one patient developed limited distal flap necrosis, both studies demonstrate that preservation of the posterior tibial artery combined with meticulous perforator dissection provides dependable soft tissue coverage for complex lower-leg defects. Similar to Gao et al., donor-site morbidity in our series was minimal, with all donor sites managed successfully using split-thickness skin grafting.

Different modifications of posterior tibial artery perforator flaps have also been described to improve flap mobility and minimize complications. Almishal et al. reported successful reconstruction of three small- to medium-sized lower limb defects using a posterior tibial artery perforator V-Y advancement flap, with complete healing and no flap-related complications.[12] In contrast, all flaps in our study were designed as propeller flaps rather than V-Y advancement flaps, reflecting our preference for greater arc of rotation when reconstructing distal leg and ankle defects. Nevertheless, both studies emphasize that careful flap planning, meticulous perforator dissection, and strict postoperative monitoring are fundamental to achieving successful outcomes regardless of flap geometry.

For larger and more complex defects, Liu X et al. described a free extended posterior tibial artery perforator flap incorporating the neurovascular plexus of the saphenous nerve branch, allowing reconstruction of extensive soft tissue defects while improving sensory recovery. Their technique achieved complete flap survival and satisfactory sensory restoration in all patients but required microsurgical expertise and vascular anastomosis.[13] In contrast, our study focused on pedicled posterior tibial artery perforator flaps, which avoid microsurgical anastomosis while providing reliable coverage for moderate-sized distal leg and ankle defects. This highlights that pedicled perforator flaps remain an attractive alternative in appropriately selected patients where free flap reconstruction may not be necessary.

Venous congestion remains the most frequently reported complication following perforator propeller flap reconstruction. In our series, early venous congestion occurred in two patients and resolved with limb elevation and release of tight sutures without compromising flap survival. This finding is supported by the recent systematic review by Matarazzo S et al., which analyzed 619 propeller flaps for acute lower limb trauma reconstruction and reported an overall flap survival of 97%, with venous congestion identified as the leading cause of flap compromise. The review also demonstrated a significantly higher complication rate with flap rotation angles of 150° or greater.[14] Although flap rotation angles in our series ranged from 90° to 180°, careful perforator preservation, avoidance of pedicle torsion or compression, and vigilant postoperative monitoring likely contributed to the favorable clinical outcomes despite the occurrence of transient venous congestion.

The present study also demonstrates the practical utility of posterior tibial artery perforator flaps in routine orthopaedic reconstructive practice. The technique preserves the major posterior tibial arterial axis, provides thin and pliable tissue with satisfactory color and texture match, eliminates the need for microsurgical vascular anastomosis, and can be performed using standard surgical instruments with relatively low donor-site morbidity. These characteristics make it particularly useful for moderate-sized distal leg and ankle defects when local tissue is available and free tissue transfer is either unnecessary or unavailable.

Several limitations should be acknowledged. This study represents a single-center prospective case series with a relatively small sample size and no comparison group. The follow-up period was modest, limiting assessment of long-term durability and donor-site outcomes. Furthermore, functional recovery, cosmetic satisfaction, and patient-reported outcomes were not evaluated using validated assessment instruments. Finally, statistical comparisons with alternative reconstructive techniques could not be performed because of the observational study design. Larger multicenter prospective comparative studies incorporating standardized functional outcome measures are required to further define the role of posterior tibial artery perforator flaps in lower limb reconstruction.

Conclusion

Posterior tibial artery pedicled perforator flaps can be considered a reliable and technically feasible option for reconstruction of selected distal leg and ankle soft tissue defects. In this prospective case series, the technique demonstrated a high flap survival rate with an acceptable complication profile while preserving the major vascular axis. However, larger comparative studies with longer follow-up and validated functional outcome measures are required before broader recommendations can be made.

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