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RECONSTRUCTION OF LOWER LEG BURNS WITH ACHILLES TENDON AND TIBIAL EXPOSURE USING POSTERIOR TIBIAL ARTERY PERFORATOR FLAP: A REPORT OF SIX CASES

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ABTRACT

Background: *Deep burns of the lower leg and ankle caused by motorcycle exhausts frequently lead to exposure of tendon or bone, where skin grafts alone are insufficient. The posterior tibial artery perforator (PTAP) flap provides reliable vascularized tissue with minimal donor morbidity and may be a valuable reconstructive option.*

Methods: *From June 2023 to September 2025, six patients with full-thickness lower leg burns and exposed Achilles tendon and tibia, underwent reconstruction with PTAP flaps at the National Burn Hospital, Hanoi. Flaps were designed with hand-held Doppler-guided perforator mapping. Clinical outcomes were evaluated with regard to flap survival, donor site management, and complications.*

Results: *Defect sizes ranged from 4 × 4 cm to 12 × 8 cm, with flap dimensions ranged from 9 × 5 cm to 16 × 10 cm and rotation arcs of 110^0 - 180^0. Donor sites were closed with split-thickness skin grafts. Four flaps survived completely, while two developed partial necrosis that healed after secondary intervention. No total flap loss occurred. All patients achieved stable coverage, maintained limb function, and reported satisfactory cosmetic outcomes.*

Conclusion: *The PTAP flap proved to be a reliable option for reconstruction of complex lower leg burns with exposure of the Achilles tendon or distal tibia*

Keywords: *lower leg burns, posterior tibial artery perforator flap, soft tissue reconstruction*

1. INTRODUCTION

Traffic-related trauma represents a major public health concern in Vietnam, where motorcycles are the predominant mode of transportation. Among these injuries, thermal burns of the lower leg caused by contact with hot motorcycle exhaust pipes are particularly common. These burns are frequently complex, often resulting in full-thickness tissue loss with exposure of the tibia or Achilles tendon. The anatomical characteristics of the ankle and distal leg-where soft tissue coverage is limited-pose significant challenges for wound management, as conventional skin grafting is generally inadequate for exposed tendon or bone [1,2].

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In such cases, flap coverage is required to achieve durable wound healing and restore function. The posterior tibial artery perforator (PTAP) flap provides a reliable source of well-vascularized tissue, minimal donor-site morbidity, and sufficient pliability for coverage of defects in the distal leg and ankle [3].

This article reports six cases of lower leg burns with Achilles tendon and tibial exposure successfully reconstructed using the PTAP flap, highlighting its effectiveness in managing complex burn injuries.

2. PATIENTS AND METHODS

Between June 2023 and September 2025, six patients with deep lower leg burns caused by contact with motorcycle exhaust pipes were admitted to the Adult Burn Department at the National Burn Hospital, Hanoi, Vietnam. All patients presented with full-thickness burns with exposure of the Achilles tendon and/or distal tibia.

Definitive surgical reconstruction was performed after thorough wound debridement and adequate control of local infection. The posterior tibial artery perforator flap was planned based on preoperative handheld Doppler to identify suitable perforators. Flap elevation was carried out under tourniquet control, and the flap was rotated or advanced to achieve defect coverage. Donor sites were closed primarily whenever feasible, or alternatively covered with split-thickness skin grafts (STSG). Postoperative assessment focused on flap viability, wound healing, and donor site morbidity.

Figure 1. Case 1: Achilles tendon necrosis reconstructed with a posterior tibial artery perforator flap, achieving primary healing

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Figure 2. Case 2: Achilles tendon and medial malleolus exposure treated with a posterior tibial artery perforator flap; distal necrosis required secondary closure

Figure 3. Case 3: Distal tibial bone exposure after failed grafting reconstruction with a posterior tibial artery perforator flap.

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Figure 4. Case 4: Medial malleolus defect covered by a posterior tibial artery perforator flap rotated 180°, with complete healing.

Figure 5. Case 5: Long tibial bone exposure managed with a reduced posterior tibial artery perforator flap size and split-thickness skin graft.

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Figure 6. Case 6: Medial malleolus exposure reconstructed with a posterior tibial artery perforator flap; distal necrosis managed with secondary skin grafting.

3. RESULTS

Between June 2023 and September 2025, six patients (5 males and 1 female) with deep lower leg burns involving the Achilles tendon and/or distal tibia underwent reconstruction using the PTAP flap. The mean patient age was 46.5 years (range, 32-62 years). Defect sizes ranged from 4 × 4 cm to 12 × 8 cm, and flap dimensions ranged from 9 × 5 cm to 16 × 10 cm. Flap rotation angles varied between 110° and 180°, and the distance from the tip of medial malleolus to the perforator ranged from 8.5 cm to 17 cm (Table 1).

All donor sites were covered with STSG. Flap survival was achieved in all cases; however, partial flap necrosis occurred in two patients (cases 2 and 6), which was managed successfully with local wound care and secondary grafting. No total flap loss was observed.

Functional outcomes were preserved in all patients, including ankle mobility and lower leg function. Aesthetic outcomes were acceptable, and patients expressed satisfaction with the reconstruction.

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Table 1. Clinical data and outcomes of six patients treated with posterior tibial artery perforator flaps

Patient Number	Age	Gender	Expose structure	Defect size (cm)	Flap size(cm)	Flap rotation angle	Distance* (cm)	Closure of donor site	Flap outcome
1	58	Male	Achile tendon	6x4	14x6	150	11.5	STSG	Survival
2	42	Female	Achile tendon Medial malleolus	11x 8	16x10	180	10	STSG	Partial necrosis
3	50	Male	Tibial	4x4	9x5	110	8.5	STSG	Survival
4	32	Male	Medial malleolus	5x5	17x5	180	11	STSG	Survival
5	35	Male	Tibial	12x8	13x6	180	17	STSG	Survival
6	62	Male	Medial malleolus	6x6	12x5	180	10	STSG	Partial necrosis

**Distance from the tip of medial malleolus to perforator vessels*

4. DISCUSSION

PTAP flaps have consistently proven effective in reconstructing complex lower leg and ankle wounds, including those with exposed tendon, bone, or internal fixation hardware [4-6].

Their dependable vascular anatomy makes them particularly valuable in managing post-traumatic and postoperative defects where conventional options often fail. In contrast to skin grafts or random local flaps, which lack durable vascularity, posterior tibial perforator flaps supply well-perfused tissue capable of reliably covering poorly vascularized structures such as tendons or orthopedic plates [4]. Compared with free flaps, they offer clear advantages: no need for microsurgical anastomosis, shorter operative times, and less donor site morbidity, while maintaining sufficient arc of rotation and pliability for distal coverage. These features make them especially suitable for elderly patients or treatment in facilities without microsurgical capacity.

Anatomical studies have shown that PTAP cluster in reproducible regions of the medial leg, typically between 4 - 9 cm, 13 - 18 cm, and 21 - 26 cm above the tip of medial malleolus [7]. Clinically, reliable perforators are commonly identified 6 - 8 cm and 10 - 12 cm above the tip of medial malleolus, making them suitable for propeller flap design in the distal leg and ankle [7]. On average, the posterior tibial artery provides about 2.11 ± 1.05 perforators per leg, each with a mean pedicle length of 28.2 ± 10.6 mm and a diameter of 1.21 ± 0.24 mm. These vessels are most frequently located in the middle third of the lower leg (35-65%) and less commonly in the distal third (10 - 30%) [8].

The vascular reliability of the PTAP flap can be explained by the *perforasome theory*, which states that each perforator

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supplies a distinct vascular territory interconnected through direct and indirect linking vessels [9]. This anatomical principle supports the ability of a single clinically significant perforator to sustain large fasciocutaneous flaps, even when rotated widely, as observed in our series. Yu et al. demonstrated that removal of deep fascia or subcutaneous fat in the distal portion of the flap did not significantly compromise perfusion, whereas elimination of subcutaneous adipose tissue proximally resulted in a marked reduction of vascular territory [10]. These findings underscore the importance of preserving proximal subcutaneous tissue during flap elevation to minimize the risk of partial necrosis as well as enlargement of the skin flap.

Despite favorable outcomes, partial necrosis remains a concern. In a retrospective review of 59 patients, Peng et al. identified flap width as an independent predictor of necrosis, with designs exceeding 6 cm significantly increasing the risk (OR = 4.028; P = 0.041). This suggests that flaps extending beyond the vascular territory of a single perforator are more vulnerable to distal ischemia [11]. Additional contributors include excessive flap length, torsion at the pivot point, and inadequate venous drainage, while systemic conditions such as diabetes and peripheral vascular disease may further compromise flap survival [3]. Careful preoperative perforator mapping, restricting flap width, meticulous dissection to preserve both arterial inflow and venous return are essential strategies to reduce complications [7]. During flap harvest, the perforating artery should be carefully dissected for a length of 2-3 cm to minimize the risk of pedicle torsion during flap rotation [3].

Thus, these anatomical insights provide a strong theoretical basis for the clinical reliability of posterior tibial artery perforator flaps and help explain the partial flap loss observed in some cases.

5. CONCLUSION

In this case series, the PTAP flap proved to be a reliable option for reconstruction of complex lower leg burns with exposure of the Achilles tendon or distal tibia. The flap provided durable soft tissue coverage, preserved ankle and lower leg function, and resulted in acceptable aesthetic outcomes. Partial flap necrosis may occur and should be anticipated in surgical planning. While these results are encouraging, larger studies with long-term follow-up are warranted to further evaluate the safety, efficacy, and optimal application of this flap in lower leg burn reconstruction.

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