

# Distal posterior tibial artery perforator flaps for the management of calcaneal and Achilles tendon injuries in diabetic and non-diabetic patients

Ioannis A. Ignatiadis, MD, PhD<sup>1\*</sup>, Georgios D. Georgakopoulos, MD<sup>1</sup>, Vassiliki A. Tsiampa, MD<sup>1</sup>, Vasilios D. Polyzois, MD, PhD<sup>2</sup>, Dimitrios K. Arapoglou, MD<sup>1</sup> and Apostolos E. Papalois, PhD<sup>3</sup>

<sup>1</sup>Hand Surgery-Upper Limb and Microsurgery Department, KAT General Hospital, Athens, Greece; <sup>2</sup>2nd Orthopedic Department, University of Athens Medical School, Athens, Greece; <sup>3</sup>ELPEN Pharma-CO, Pikermi, Attika Experimental-Research Center, Athens, Greece

Management of Achilles tendon and heel area defects is a common challenge for the reconstructive surgeon due to the lack of soft tissue availability in that region. In this article, we present our experience in covering these defects by using the distal perforator propeller flaps based on the posterior tibial artery. Perforator flaps are based on cutaneous, small diameter vessels that originate from a main pedicle and perforate the fascia or muscle to reach the skin. Their development has followed the understanding of the blood supply from a source artery to the skin. Six patients (five males and one female) underwent reconstruction by using the posterior tibial artery distal perforator flap for covering defects in the distal Achilles tendon region in patients with and without diabetes mellitus. Postoperative complications included a hypertrophic scar formation in one patient, partial marginal flap necrosis in another patient, and a wound infection in a third patient. All wounds were eventually healed by the last postoperative visit. In conclusion, perforator flaps based on the distal posterior tibial artery may be a reliable option for the coverage of small to moderate size defects of the Achilles tendon and heel area regions.

**Keywords:** *reconstructive foot surgery; flaps; diabetes; Achilles tendon; plastic surgery*

Received: 21 June 2011; Revised: 16 July 2011; Accepted: 18 July 2011; Published: 12 August 2011

Perforator flap reconstruction began in 1989 with the utilization of the inferior epigastric artery skin flap and without the rectus abdominis muscle for the reconstruction of the floor of the mouth and groin defects as described by Saint-Cyr and Schaverien (1). A propeller perforator flap is defined as an island flap with an axial rotation (2). It can be rotated from an angle of 90°–180°. It is usually not necessary to rotate beyond 180°, as it can be simply rotated in the other direction. The direction of rotation depends on the angle between the proximal long axis of the flap and the defect (3).

The posterior tibial artery is the direct continuation of the popliteal artery and usually the dominant vessel of the trifurcation (4). It is accompanied by two venae comitantes and through its course in the leg supplies two to four perforators, each accompanied by two venae

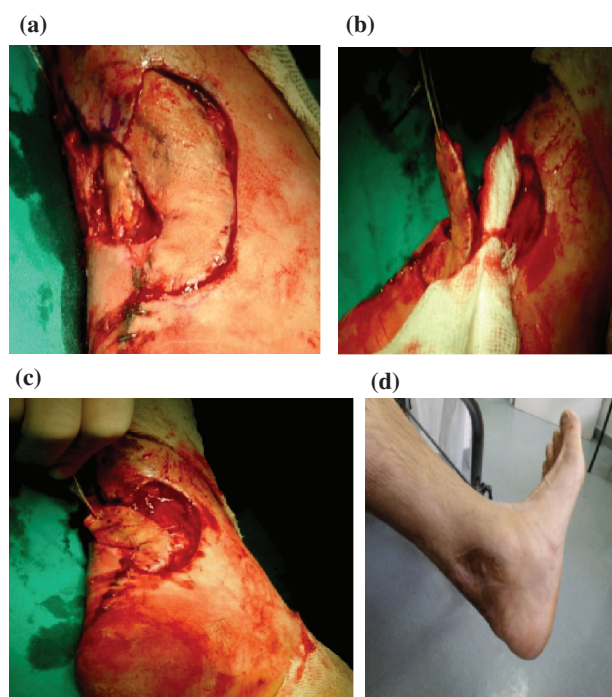
comitantes (venous perforators from the greater saphenous vein) predominantly septocutaneous and arising from within two intermuscular septa: one between the soleus and the flexor digitorum longus muscle and the other between the flexor digitorum longus muscle or tendon and the medial aspect of the tibia (5, 6). Although most of the studies mention that posterior tibial artery perforators emerge at 4–26 cm from the intermalleolar line (7), some argue different levels of emergence, concluding that patients have their own individual patterns (8). In our case series there was always a perforator at the level of medial malleolus that could easily be identified with the Doppler probe preoperatively. The veins accompanying these arteries show anatomic variations (two, one, or even none of the veins accompanying the artery), which is important to the

initial survival of these flaps (9). The posterior tibial artery perforators are connected in an axial network, allowing the surgeon to raise large designed flaps that can inset into defects of different sizes and shapes (10).

### Surgical technique

Preoperatively, the posterior tibial artery perforators are identified and marked on the skin using a hand-held Doppler probe. Identification of the surrounding perforators enables the surgeon to delineate the angiosome supplied by a single perforator and the extent of its perfusion. The patient is placed in the supine position with the leg slightly abducted and externally rotated. A thigh tourniquet is used without fully exsanguinating the leg to allow easier identification of the perforators during exploration. After surgical excision of any necrotic or infected tissue, the size of the defect is revealed. A potential flap is then drawn adjacent to the defect. The side of the flap closer to the defect is raised first in a subfascial plane and until at least one of the perforators is found. The shape of the flap can then be re-evaluated and adjusted according to the location of the perforator. The remaining outline of the flap is then incised and the flap is undermined until it is completely islanded. The perforating artery and the concomitant veins are dissected directly or close to the posterior tibial artery, long enough to prevent kinking of the vessels when the flap is repositioned. The raised flap can now be rotated around the perforator into the defect in an angle of  $90^{\circ}$ – $180^{\circ}$  (Fig. 1:  $45^{\circ}$  rotation, Fig. 2:  $90^{\circ}$  rotation, Fig. 3:  $180^{\circ}$  rotation).

In all of our cases, the donor area was covered with a split thickness skin graft harvested from the thigh. Hydration of the patient, leg elevation, and maintenance of adequate blood pressure and temperature (to prevent spasm of the perforating artery) are critical for the first postoperative 48 hours. Clinical monitoring of the flap to detect intrinsic vascularity problems (vasospasm) as well as extrinsic causes of perfusion compromise (hematoma, edema, and external pressure) is essential for the patient's successful outcome. This involves close monitoring of the skin color, capillary refill, skin temperature, and evidence of postoperative bleeding. The flap is monitored hourly

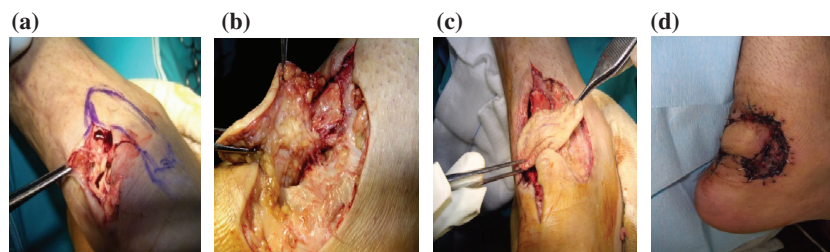


**Fig. 1.** Intra-operative picture showing the raising of the posterior tibial artery perforator flap (a), inset at about  $45^{\circ}$  rotation (b, c), and final postoperative outcome (d).

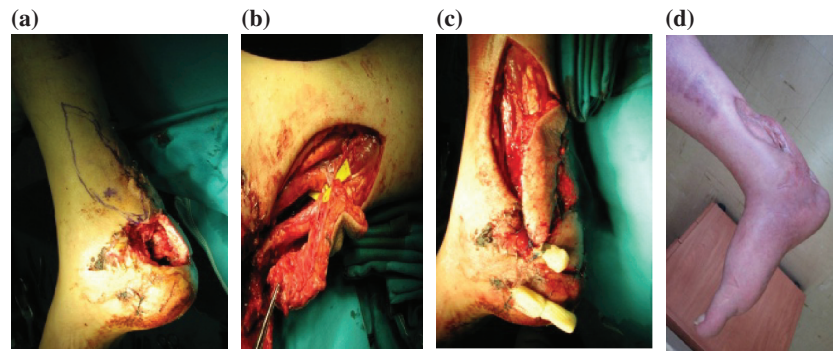
during the first 24 hours and every 4 hours for the next 24 hours. The first skin grafting dressing is usually performed on the 5th postoperative day and flap sutures are removed on the 14th postoperative day.

### Materials and methods

From 2004 to 2009 six patients (five males, one female), with a mean age of 46 years old (range from 35 to 58 years), were admitted into our department and operated on with skin necrosis and injuries in the Achilles tendon region. Demographic information were collected, as well as the type and location of the defect, causes of injury, comorbidities, time from the initial operation to flap harvesting, flap type and complications secondary to the operation, and final result. Five of the patients were smokers, four were diabetic, and in four of them the injury was combined with a concomitant Achilles tendon



**Fig. 2.** Intra-operative picture showing the raising of the posterior tibial artery perforator flap (a), inset at about  $90^{\circ}$  rotation (b, c), and final postoperative outcome (d).



**Fig. 3.** Intra-operative picture showing the raising of the posterior tibial artery perforator flap (a), inset at about a 180° rotation (b, c), and final postoperative outcome (d).

rupture. Only one underwent a secondary operation due to a partial marginal flap necrosis, which was treated by further surgical debridement and wound closure. With the exception of one case with an Achilles tendon detachment and calcaneal avulsion fracture where the patient underwent a partial proximal bone excision and tendon reattachment by anchors fixation, all the other cases were treated with debridement and repair of the Achilles tendon. In that particular case, we performed two flaps, initially a sural fasciocutaneous flap and then a medial perforator fasciocutaneous propeller flap due to partial necrosis of the former. The rest of the patients

underwent a posterior tibial artery distal perforator flap. In the five cases, the ankle was immobilized with a dorsal below knee plaster splint in a neutral position (90°–100°) for 3–4 weeks, followed by 5–6 weeks offloading; while in the case where we performed two combined flaps, immobilization was for a total of 6 weeks, followed by offloading of 8 weeks. After the immobilization period, the patient started to walk using a fracture boot for an additional 4–6 weeks. After the 6th week, the patient started a full weight bearing status without any assistant devices. No complications like osteomyelitis or soft tissue infection recurrence have been observed.

**Table 1.** Clinical and demographic data of all patients

Case	Age, gender	Initial type of injury and location of defect	Operation	Past medical and social history	Surgery timing from initial surgery	Complications
1	40, Male	Achilles tendon rupture – middle region	Tendon debridement and posterior tibial artery distal perforator flap	Diabetes mellitus and chronic smoker	3 weeks	None
2	44, Male	Achilles tendon rupture – middle region	Tendon debridement and posterior tibial artery distal perforator flap	Chronic smoker	8 weeks	None
3	56, Female	Achilles tendon rupture – middle region	Tendon debridement and posterior tibial artery distal perforator flap	Diabetes mellitus	10 weeks	Superficial wound dehiscence
4	35, Male	Achilles tendon rupture – middle region	Tendon debridement and posterior tibial artery distal perforator flap	Diabetes mellitus and chronic smoker	9 weeks	Hypertrophic cheloid scar
5	58, Male	Achilles insertion detachment with calcaneal avulsion fracture and failed reduction	Partial proximal bone excision with tendon reattachment and combined sural and posterior tibial artery distal perforator flap	Diabetes mellitus and chronic smoker	4 weeks	None
6	42, Male	Achilles tendon rupture – distal region	Tendon minimal resection and posterior tibial artery distal perforator flap	Diabetes mellitus and chronic smoker	10 months	Partial marginal skin flap necrosis

## Results

All flaps survived and provided stable coverage of the defect and adequate soft tissue contour. The postoperative follow-up of the operated patients was between 1.5 and 7 years. In one case, there was a partial marginal necrosis due to venous congestion that was managed with debridement, skin mobilization, and re-suture. With the exception of the case with the Achilles insertion detachment and calcaneal avulsion fracture, all the other cases were approached with debridement and thinning of the tendon. Although no reconstruction was performed on the partially debrided and thinned tendon, the functional results were mostly good. Early progressive ambulation of the patients was feasible, minimizing any risk associated with prolonged immobilization and decreasing hospitalization. Major complications like osteomyelitis or soft tissue infection recurrence were not observed in any of our patients. Table 1 summarizes the clinical and demographic data of all patients.

## Discussion

Soft tissue coverage of the lower leg can be a challenging problem. Currently, cross leg flaps are rarely used and free flaps provide a reliable coverage but it is a time-consuming operation with a significant risk for patients with co-morbidities and especially those with diabetes mellitus. The use of the posterior tibial perforator flap can provide coverage of defects utilizing short operative time with minimal complications by preserving the underlying muscles and major arteries while being technically less demanding. Although most of the studies mention that the perforators emerge at 4–26 cm from the intermalleolar line (7), in our cases there was always a perforator at the level of medial malleolus that could easily be identified with the Doppler probe preoperatively. Muscle flaps traditionally are considered as a better coverage for infected wounds and resected osteomyelitic areas, but there are several clinical studies who have failed to demonstrate a difference (11–13). For the Achilles tendon and heel area injuries and defects, fasciocutaneous rather than muscle flaps are usually indicated. Muscle flaps fill three-dimensional defects and fasciocutaneous flaps are mostly used for the coverage of shallow wounds restoring the contour of the area. The aesthetic and functional results in our study were widely acceptable as skin of similar texture, thickness, and color to that which was originally lost.

## Conclusion

The posterior tibial perforator flap is another option for closure of diabetic and non-diabetic wounds in the ankle

and most proximal foot regions. Overall, medical and postoperative management of these reconstructive flaps is paramount to the patient's successful outcome.

## Conflict of interest and funding

The author have not received any funding or benefits from industry or elsewhere to conduct this study.

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\*Ioannis A Ignatiadis, MD, PhD

Hand Surgery-Upper limb and Microsurgery Department  
KAT Hospital  
Athens, Greece  
Email: ignatioa@yahoo.com