

Posterior tibial artery perforator flaps: Case series

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ABSTRACT

Introduction: Coverage defects in the leg are a challenge due to the particulars of the anatomy in said area. Therefore, different reconstruction strategies have been developed, being the fasciocutaneous perforator flaps the most frequently used. The aim of this paper is to discuss the therapeutic alternative and to describe the surgical technique, the results and the complications of the posterior tibial artery perforator flap (PTAPF) to treat coverage defects. **Materials and Methods:** We performed a retrospective review of patients treated with a fasciocutaneous flap. We analyzed preoperative demographic variables. The surgical technique and the indications in each patient are described. Finally, the postoperative variables, such as complications and flap survival, were analyzed. **Results:** Twelve patients (all male) treated with PTAPF were included. The average age at the time of surgery was 52 years (range: 29-77 years). The maximum follow-up was 55 months, with a minimum of 5 months (average: 18 months). There were two flaps with transient congestion that reverted spontaneously: one partial failure and one total failure. **Conclusions:** Posterior tibial artery perforator flaps should be considered as a viable option for the treatment of small- and medium-sized leg wounds, since they provide similar tissue thickness, texture and color on the recipient site, achieving good clinical and cosmetic results.

Key words: Posterior tibial artery perforator flap; coverage defects.

Level of evidence: IV

Colgajo de perforante de la arteria tibial posterior. Serie de casos

RESUMEN

Introducción: Los defectos de cobertura en la pierna son un problema difícil de solucionar debido a las características propias de la región anatómica. Por ello, se han desarrollado distintas estrategias de reconstrucción, y los colgajos de perforante fasciocutáneos son los que se utilizan con más frecuencia. **Objetivos:** Presentar la alternativa terapéutica, describir la técnica quirúrgica, los resultados y las complicaciones del colgajo de perforante de la arteria tibial posterior para el tratamiento de defectos de cobertura en la pierna. **Materiales y Métodos:** Se realizó una revisión retrospectiva de los pacientes tratados con colgajo fasciocutáneo en la pierna y operados en nuestro Centro. Se analizaron variables demográficas preoperatorias. Se describen la técnica quirúrgica y las indicaciones en cada paciente. Se analizaron variables posoperatorias, como las complicaciones y la supervivencia del colgajo. **Resultados:** Se incluyeron 12 hombres tratados con colgajo de perforante de la arteria tibial posterior. El promedio de edad en el momento de la cirugía fue de 52 años (rango 29-77). El seguimiento máximo fue de 55 meses y el mínimo, de 5 meses (promedio 18). Hubo dos colgajos con sufrimiento transitorio, una falla parcial y una falla total. **Conclusiones:** El colgajo de perforante de la arteria tibial posterior ha de ser considerado una opción válida en el tratamiento de heridas de pequeño y mediano tamaño de la pierna. Provee de tejido similar en grosor, textura y color en el sitio receptor con buenos resultados clínicos y estéticos.

Palabras clave: Perforante de arteria tibial posterior; colgajo; defecto de cobertura.

Nivel de Evidencia: IV

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INTRODUCTION

Coverage defects in the lower limb, particularly in the leg, are quite a challenge due to the particulars of the anatomy in said area, such as the presence of bony prominences, soft tissue shortage and limited skin elasticity.^{1,2}

In the past, the local reconstructive alternatives were gastrocnemius and soleus flaps, and their use was limited to the proximal and middle third of the leg;³ reconstruction of the distal third of the leg was subject to complex options, such as a cross-leg flap or a microsurgical flap,^{2,4} and both procedures had complications and a failure rate of 15 to 20%.⁵

In turn, it is important to note that not all patients are in optimal conditions to undergo these procedures, which, added to their complexity, makes them difficult to perform.¹

Due to the aforementioned, different reconstruction strategies have been developed, such as fasciocutaneous perforating flaps; sural flaps are the most widely used approach today.^{6,7} This is due to the fact that the reverse sural flap has low local morbidity, it does not affect main vessels and it does not require a high level of experience for its execution; however, it cannot always be used to treat coverage defects of the distal third of the leg, since the defect may be located outside its coverage area, or the vascular pedicle may be injured, thus being necessary to change the surgical strategy for reconstruction of soft tissue defects.⁸ In said cases, a fasciocutaneous posterior tibial artery perforator flap (PTAPF) can be used, since it meets the same indication criteria as the sural flap by adding the primary closure of the donor area as well as the cosmetic results derived from the use of tissue similar to the recipient's.

The objectives of this paper are to present a therapeutic alternative, to describe the surgical technique, the results and the complications of the PTAPF for the treatment of coverage defects in the lower limb.

MATERIALS AND METHODS

A retrospective review of the patients treated with fasciocutaneous flap in the leg and operated on at our Center was performed by the same surgical team.

Patients with coverage defects in the anterior side of the leg with bone, tendon or cutaneous exposure were specifically included, in whom surgical reconstruction was carried out specifically with a PATPF. Preoperative, intraoperative and postoperative variables were analyzed. The preoperative variables were: body mass index, comorbidities, number of previous surgeries, cause, type of defect and indication for said flap that guided surgeons to choose this approach, and lack of other alternatives.

The intraoperative variables were: localized pedicle, size of the skin flap, degrees of flap rotation, intraoperative complications, and need for a second surgical stage. Finally, the postoperative variables were: complications, defined as venous congestion, partial or total necrosis and flap survival. Before surgery, patients were evaluated by determining the presence of perforators by Doppler ultrasound. No digital angiography was used in this series.

Surgical approach

The procedure begins with the patient in the dorsal recumbent position, with slight external rotation of the limb in question. Doppler skin mapping is performed to help locate perforators in the area of interest of the posterior tibial artery and close to the defect to be covered. Said cutaneous area is comprised between the central raphe along the Achilles tendon as the medial limit, and the inner edge of the anterior tibial crest as the anterior limit. Adjacent to the posterointernal edge of the tibia, between the soleus and flexor muscles and along the fingers, six or seven septocutaneous perforators emerge.

Depending on the location of the defect, the previous scars and the location of the perforating vessels, the proximal or distal orientation of the skin flap to be rotated will be defined, which can be 45° to 180°. Subsequently, the skin flap will be drawn on the skin to be raised, including the perforator(s) at one of its ends (Figure 1). The length of the cutaneous flap will depend on the length between the defect to be covered in its most distal area and the perforator, adding 1-2 cm according to the theoretical location of the perforator at the cutaneous level. Then the flap will be lifted (Figure 2), under limb ischemia, which can be done entirely from the area away from the perforator or on its posterior side. The search and identification of the perforating vessels defined by their entry site through the perforation of the fascia continues (Figure 3).



Figure 1. Flap planning.



Figure 2. Flap dissection.

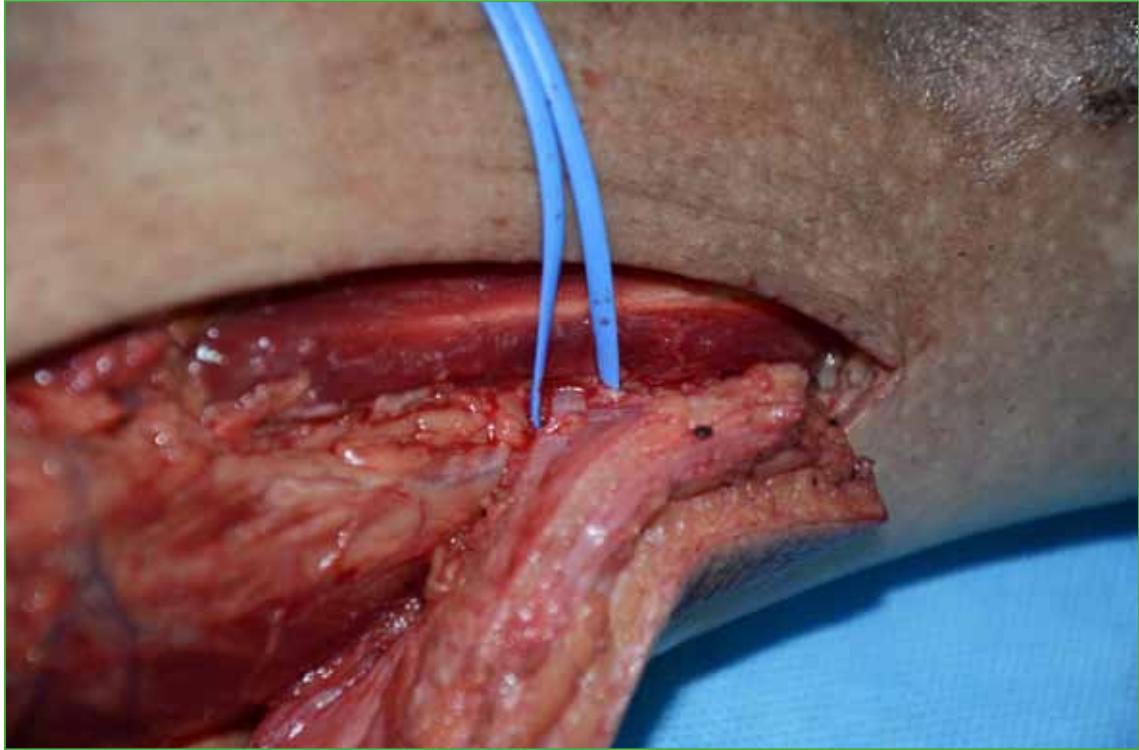


Figure 3. Identification of perforating artery through the fascia.

After identifying the perforating vessel(s) (usually no more than 2) and according to the rotation necessary to reach the defect zone, some of the perforators may be excluded to achieve the desired rotation. It should be noted that, if a rotation $>90^\circ$ is required, it is mandatory to perform a perforating pedicle release, from the perforation of the fascia to the exit of the posterior tibial artery, to reduce the possibility of a greater bending or twisting of the perforators, reducing the complications associated with venous congestion. After releasing the flap and the perforator, the ischemia is also released to check for adequate capillary filling in them and perform the corresponding hemostasis. The flap is rotated, reaching and covering the defect area, and closed with separate sutures in two planes and without tunneling it (Figure 4).

In exceptional cases, a drainage may be used in the bed of the receiving area.

Primary closure of the donor site is carried out. Depending on the underlying condition at the bone level and if a combination of procedures was performed, the placement of a posterior flap may be added to the approach.

RESULTS

Between March 2008 and 2018, 12 PATPF were carried out at our institution. All patients were men, with an average age at the time of surgery of 52 years (range: 29-77).

The average body mass index at the time of surgery was 31.4, and more than half of the patients had an index higher than 30. As preoperative history worth noting, 5 patients were smokers, 3 had type II diabetes and 1 had hypothyroidism. Four patients had no comorbidities. The diagnoses were: chronic osteomyelitis due to open fractures (6 patients: 3 of tibia and 3 of tibial plafond); sequelae of total knee prosthesis infection (2 patients) (Figure 5); open fracture of tibial and tibial plafond (2 patients); gunshot wound in the leg (1 patient); and complication of the surgical wound in a tibial plafond fracture (1 patient). The types of coverage defect of the patients were: wound necrosis (7 cases), active fistula (3 cases), and coverage defect (2 cases).

There were no patients presenting with vascular soft-tissue lesions.

Regarding the specific indication in each patient, previous surgeries, location of the defect, whether the nutrient vascular bed was intact and the topography of the defect to be covered were taken into account (Table 1).



Figure 4. A. Presentation of flap on the defect area. B. Final closure of the donor and recipient areas. C. Follow-up 4 months after surgery.



Figure 5. A. Coverage defect in the proximal third of the leg as a sequela of total knee arthroplasty infection. B. Immediate postoperative scan. C. Follow-up one year after surgery.

Table 1. Particulars of the receiving site.

Patient	Previous surgeries	Defect site	Vascular bed	Defect topography
1	Yes	Anterior middle third	Intact	1-cm fistula
2	Yes	Anteromedial distal third	Previous sural flap	10-cm necrosis
3	Yes	Anterior middle third	Intact	4-cm necrosis
4	Yes	Medial middle third	Intact	3-cm necrosis
5	Yes	Anteromedial middle third	Previous sural flap	3-cm defect
6	No	Anteromedial distal third	Peroneal artery injury	5-cm defect
7	Yes	Anteromedial distal third	Negative ultrasound of the peroneal artery	1-cm fistula
8	Yes	Anteromedial distal third	Intact	4-cm necrosis
9	Yes	Anterior proximal third	Intact	3-cm fistula
10	Yes	Anteromedial distal third	Thread-like peroneal artery	4-cm necrosis
11	Yes	Anterior proximal third	Intact	5-cm necrosis
12	No	Anterior middle third	Intact	4-cm necrosis

In cases of proximal and middle third defects in which it is usual to perform muscle flaps, it was decided to preserve the muscle by performing the PATPF. In addition to this benefit, cosmetic results were mostly satisfactory (Figure 6). On the other hand, in the cases of the 6 flaps created to treat defects in the distal region, the decision to perform this flap was justified by therapeutic limitations taking into account vascular appearance. Two patients already had undergone a previous sural flap, while another had undergone a peroneal artery flap. The remaining 3 did not have adequate perforators on Doppler ultrasound. Sural fasciocutaneous flaps depend on vascular pedicles from the peroneal artery; therefore, the PATPF was the most adequate option given this limitation.

In summary, flap sites were as follows: 2 flaps for the proximal third of the leg, 4 for the middle third and 6 for the distal third.

In three cases, surgery was performed in a single surgical stage, and 2 of these patients had an active fistula. The third patient with active fistula required a second surgical stage, in which an additional internal gastrocnemius flap was used due to partial flap failure. In the rest of the cases, the second stage was required to complete flap closure (6 patients) and to add a skin graft (1 patient). Two of the presented with suffered venous congestion that required a partial release of the flap for later wound closure after the event had passed. A single patient presented with complete failure. There were no intraoperative complications.

Two perforators were included in 6 flaps. In the remaining 6, there was only 1 perforator. The degree of rotation varied according to the patient (Table 2). The average skin flap size was 12 x 5 cm (range: 16 cm x 4 cm). The maximum follow-up was 55 months, with a minimum of 5 months (average of 18 months), excluding the failed case.

As already mentioned, there were 2 flaps with congestion stress that was resolved in a short time, a partial failure and a total failure.



Figure 6. A. Wound necrosis in the middle third of the leg. B. Immediate postoperative scan. C. Follow-up 7 months after surgery.

Table 2. Particulars of the flap.

Patient	Size	Rotation degree	Stages	Flap complications
1	10 cm x 4 cm	45°	1	-
2	14 cm x 5 cm	180°	2	Distal stress
3	11 cm x 4 cm	30°	2	-
4	14 cm x 4 cm	180°	2	Distal stress
5	8 cm x 4 cm	160°	1	Complete failure
6	10 cm x 4 cm	90°	2	-
7	14 cm x 4 cm	170°	1	-
8	12 cm x 4 cm	180°	1	-
9	15 cm x 5 cm	90°	2	Partial failure
10	16 cm x 5 cm	180°	2	-
11	14 cm x 5 cm	170°	2	-
12	10 cm x 6 cm	30°	2	-

DISCUSSION

The use of fasciocutaneous flaps has had discouraging results in the past, and the main cause was ignorance of vascular tissue patterns of local tissues.⁹ Trauma of the limb or peripheral vascular conditions affect the blood flow of the limb, making the case even more difficult.¹⁰ After several anatomical studies, reliable perforating arteries were revealed, such as those of the posterior tibial artery¹¹⁻¹³, easily identifiable by Doppler ultrasound. Most of them are of septocutaneous nature and of greater diameter at the level of the proximal third of the leg.^{11,14} The inclusion of the deep fascia enables the design of larger flaps and at the expense of a single perforator, due to extensive axial communication with the flap.⁵

Currently, the PATPF is an alternative that can be considered as the first option by orthopedic surgeons. It was described by Pontén¹⁵ in 1981, who described it as a first adequate alternative for distal defects of the lower limb due to its versatility, cosmetic appearance and low morbidity of the donor site. Its versatility lies in the possibility of being transported or rotated up to 180° on its pedicle, and that its pivot point is proximal or distal, thus extending the coverage range to the entire anterior side of the limb.^{5,16,17} With its use, the main arteries that supply blood to the foot are preserved, with minimal lesion to the donor site, due to the fact that the primary closure is possible without the need to add a graft, as often occurs with reverse-flow sural flaps. Surgical stages are shorter and do not require microsurgical anastomosis. The advantages of PATPF also lie in cosmetics, due to the similar texture, thickness and color of the skin and the receiving site, thus avoiding interfaces.^{2,4,11,18} Its utility stands out as a rescue flap after a failed sural flap, as well as when it is not possible to use a reverse-flow sural flap due to involvement of the pedicle feeding it, since it may be affected due to trauma of the lower limb or to previous surgeries on that area.

CONCLUSIONS

The PATPF must be considered an adequate option for the treatment of small and medium-sized wounds, ranging from the proximal third to the distal third of the leg. It provides a similar tissue with regards to thickness, texture and color in the recipient site, with little morbidity in the donor site, which brings about good clinical and cosmetic results. In turn, it is an indication if a reverse-flow sural flap is not possible or as a rescue after failure of said flap.

Conflict of interest: Authors claim they do not have any conflict of interest.

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