

## Case Series

# Distally based peroneus brevis muscle flap for the use of reconstruction of lower third defects of leg and ankle

A. Ravi Chandra Mohan, Jyotsna Poldas, Vaibhav Thobbi\*

Department of Plastic and Reconstructive Surgery, Government General Hospital, Vijayawada, Andhra Pradesh, India

**Received:** 09 September 2023

**Revised:** 13 October 2023

**Accepted:** 16 October 2023

**\*Correspondence:**

Dr. Vaibhav Thobbi,

E-mail: vaibhavthobbi@gmail.com

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

### ABSTRACT

Peroneus brevis is a muscle in the lateral compartment of the leg which is expendable with minimal functional deficit. The objective of this study was to find out its use in the coverage of the defects of the lower third of leg and ankle. A retrospective analysis of the use of pedicled peroneus brevis muscle flaps used for coverage of defects of the lower third defects of leg and ankle between May 2022 and 2023 was carried out among 10 patients with said defects. The flaps were distally based for defects the lower third of leg and ankle. Split skin graft coverage was done in all cases. The distally based peroneus brevis muscle flap was used in a series of 10 patients with defects over the lateral malleolus (40%), anterior lower 1/3rd of tibia (40%) and tendoachilles (20%). Flap survival was 100% in all cases with 3 cases having 20% split skin graft loss. Donor site healed well in 100% of cases and no long term muscle function deficit was observed in all cases. This flap has a unique vascular pattern and falls into the type-4 muscle flap category under the Mathes and Nahai Classification. The flap is simple to raise and safe for the reconstruction of small-to moderate-sized skin defects of the distal third of the tibia and all parts of the ankle except the medial malleolus, which is too far from the pedicle of the distally based flap.

**Keywords:** Ankle defects, Lateral malleolus defects, Lower leg defec, Muscle flap, Peroneus brevis flap, Pedicle flap, Tendo achilles defects

### INTRODUCTION

The coverage of soft tissue defects with exposed vital structures of the lower third of the leg and the ankle is an ever changing and dynamic field of constant innovation and research in the field of plastic surgery.

The flaps employed initially were bulky flaps which led to problems with cosmesis both at the donor and inset sites. This is particularly a problem when defects are small to moderate in size and lie over the malleoli or tendo achilles. The revolution of local flaps, mostly fasciocutaneous, which are now available for the reconstructions of the ankle usually fail to avoid bulk at the ankle and leave significant adjacent donor defects proximally.<sup>1</sup> Although free flaps avoid the adjacent

cosmetic donor defects, they have the same problems as with previously used local flaps with regards to bulk of tissue at the recipient site, only not seen in very thin patients due to less subcutaneous fat.

Due to the considerably larger volume of tissue required to raise a free flap, they are not suitable for coverage of small to medium sized defects.<sup>2</sup> They also have higher rates of complications.<sup>3</sup>

Muscle flaps, whether pedicle or free, have the benefit of 'autothinning' with time, as the muscle atrophies, the need for a skin graft coverage initially leads to mismatch at the defect site but with time, as the graft settles, the results are similar in terms of aesthetic outcome.<sup>3</sup> This paper reports the use of the pedicled distally based peroneus brevis

muscle flap in 10 patients used for reconstruction of defects of the lower third of the leg and ankle.

## CASE SERIES

Over the period between May 2021 and 2023, 10 patients, including 2 females and 8 males with a mean age of 38 years (range: 22-50) years, presented with injuries of the distal third of the leg or ankle requiring flap cover of exposed bone, open joints, bare tendon or exposed hardware, which were small to moderate in size with the average size of the defect measuring 15 cm<sup>2</sup> (10-20 cm<sup>2</sup>).

Pre-operatively, the presence of peripheral pulses was confirmed to rule out vascular injury and peripheral vascular disease. No angiograms were done and it was not possible to isolate the perforator with Doppler study. Usually, fracture of the fibula does not disturb the vascularity to the muscle. Even when a distal fracture is fixed, the perforators remain undisturbed as the dissection is in the subperiosteal plane.<sup>4</sup>

### Surgical anatomy

The peroneus brevis muscle is deep and anterior to the peroneus longus muscle originating from the junction of the upper and middle third junction of the lateral surface of the fibula. It is muscular up to, and sometimes beyond, the lateral malleolus and is inserted into the base of the fifth metatarsal. In the literature, it is described as a type IV muscle based on its vasculature.<sup>5</sup> Proximally, the neurovascular bundle enters the muscle within 2-4 cm of the upper end of the muscle. Several branches from peroneal vessels pierce the posterior septum and supply the muscle. It receives a few branches from the anterior tibial artery also. Distally the muscle can be based off a reliable perforator that enters the muscle 5-7 cm proximally from the tip of the fibula.

The superficial peroneal nerve traverses the compartment on the anterior surface of the muscle, which is easily identified and separated from the muscle up to the point of the middle of the leg where it pierces the anterior septum to become subcutaneous.<sup>6</sup>

### Surgical technique

All of the procedures were performed under tourniquet control and spinal anaesthesia, all patients remained in a supine position throughout the operation. The foot was held in place with the knee in 60-70° of flexion to prevent the foot from sliding down and to allow the ankle to rest in plantar flexion, and to relax the peroneus muscles and allow easy access to the peroneus brevis, lying deep to the peroneus longus.

The incision is made 1 cm posterior to the line of the fibula and deepened through the deep fascia to expose the peroneal compartment. It is easy to identify the peroneus longus tendon overlying the brevis tendon distally and

separate the longus from the brevis from distal to proximal. The axial vessel system vital to the viability of the peroneus brevis flap is on the posterior surface of the peroneus brevis muscle close to the posterior septum, and has to be identified and protected.<sup>7</sup>

Immediately anterior to this axial vessel is the attachment of the brevis muscle to the lateral surface of the fibula. It is important that the fibular periosteum is not raised with the muscle as this may give rise to heterotrophic ossification.

Proximally, the branch of the superficial peroneal nerve to the peroneus brevis is accompanied by blood vessels to the muscle. There is also always a constant proximal perforator branch to the brevis muscle within 2-4 cm of its origin, which is the main pedicle of the proximally based flap. Another constant perforator to the muscle lies 6-8 cm from the lateral malleolus. This is most often the main pedicle of the distally based flap.<sup>8</sup>

When planning a distally based flap, we initially keep 6-8 cm from the lateral malleolus to ensure inclusion of the distal constant peroneal artery perforator. During dissection, between the brevis muscle and the anterior septum, it is also necessary to identify and preserve any significant branches of the anterior tibial vessels perforating the anterior septum distally and leave these intact to enhance the vascularity of the distally based flaps. During this part of the dissection, care must be taken to protect the superficial peroneal nerve, which lies between the muscle and the anterior septum before passing through the fascia in the middle of the leg to enter the subcutaneous fat.<sup>9</sup>

In most cases, the constant distal perforator remains intact. However, occasionally, this has to be clamped, then ligated to allow the muscle to mobilise distally. This leaves the muscle vascularised on more distal perforators. These are not dissected out if the axial vessel system is obvious distally at the level of the distal constant perforator. However, if the axial system is not obvious at this point, the more distal perforators must be identified visually before clamping the distal constant perforator or any other perforators distal to this.<sup>10</sup>

Mobilizing the flap for final inset can involve either incising the skin bridge, which is done mostly for lateral malleolar defects or by tunnelling subcutaneously, which is done mostly for defects over the tibia and anterior ankle. The muscle is inset, taking care to anchor the deep surface of the muscle to the wound while protecting the axial vessel on this surface. A split skin graft is then applied to the superficial surface of the muscle. Immediately after surgery, all of these reconstructions are protected in a plaster of Paris ankle slab, Hospital stay is often determined by other injuries, but hospitalisation for this procedure alone has a median stay of 7-8 days, with the plaster slab remaining *in situ* for 3 weeks. Once the skin graft over the muscle flap has stabilised,

mobilisation is largely determined by orthopaedic and associated injury factors.<sup>11</sup>

**Assessment**

In this assessment, flap loss, either non-critical loss (usually distally) or loss with exposure of the underlying bone, open joints, bare tendon or implants was recorded for each target area.

Short to medium term assessment of these patients included recording the immediate complications of surgery which included bleeding/hematoma formation, partial or full thickness flap loss and graft loss. Intermediate to long term assessment of reconstructions of the region, with more than 9 months of follow-up, were available for some patients and included consideration of the bulk, appearance of the ankle and the functional and cosmetic defects of the donor site.<sup>12</sup>

**Table 1: Pre-operative assessment of the patients selected for the study.**

S. no.	Age of the patient (years)	Sex of the patient	Mode of injury	Defect location	Previous intervention (if any)	Patient comorbidities	Defect size in cm <sup>2</sup>
1	36	Male	Road traffic accident	Lower 1/3rd of leg with exposed lateral malleolus	None	None	10
2	35	Male	Road traffic accident	Lower 1/3rd of leg with exposed tibia	External fixator in view of distal 1/3rd both bone fracture	None	15
3	45	Male	Road traffic accident	Lower 1/3rd of leg with exposed fibular plate	Fibular plating for distal fibular fracture	Hypertension	20
4	38	Male	Road traffic accident	Lower 1/3rd of leg with exposed tibia	Intramedullary nailing done for tibial shaft fracture	None	10
5	28	Male	Road traffic accident	Lower 1/3rd of leg with exposed fibular plate	Fibular plating done for distal fibular fracture	None	10
6	50	Female	Accidental fall at home	Posterior ankle with exposed tendoachilles	None	Diabetes+ hypertension+	15
7	22	Male	Assault by sharp object	Lower 1/3rd of leg with exposed tibia	None	None	15
8	46	Female	Accidental fall at home	Lower 1/3rd of leg with exposed tendoachilles	None	None	10
9	38	Male	Workplace injury-avulsion injury	Lower 1/3rd of leg with exposed tibia	None	Diabetes	15

**Table 2: Post-operative assessment of the flap.**

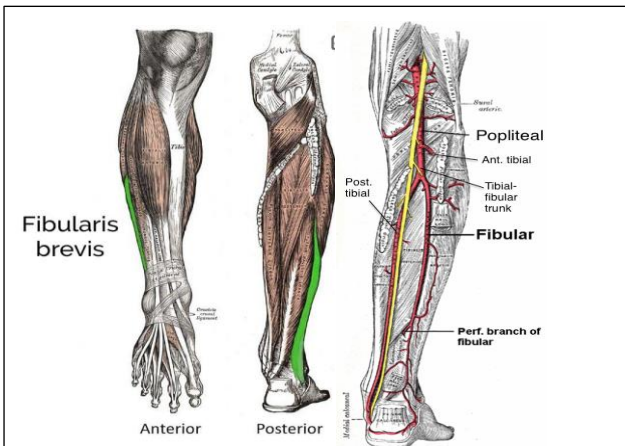
S. no.	Flap colour	Flap loss	Skin graft condition	Donor site	Flap condition at follow up	Partial/total flap loss
1	Good	None	100% uptake	Healed well	Good	No flap loss
2	Good	None	80% uptake	Healed well	Good	No flap loss
3	Good	None	100% uptake	Healed well	Good	No flap loss
4	Good	None	100% uptake	Healed well	Good	No flap loss
5	Good	None	100% uptake	Healed well	Good	No flap loss

Continued.

S. no.	Flap colour	Flap loss	Skin graft condition	Donor site	Flap condition at follow up	Partial/total flap loss
6	Dusky	10%-partial loss	80% uptake	Healed well	Good	10% partial flap loss
7	Good	None	100% uptake	Healed well	Good	No flap loss
8	Dusky	None	80% uptake	Healed well	Good	No flap loss
9	Good	None	100% uptake	Healed well	Good	No flap loss
10	Good	None	100% uptake	Healed well	Good	No flap loss

**Table 3: Summary of results.**

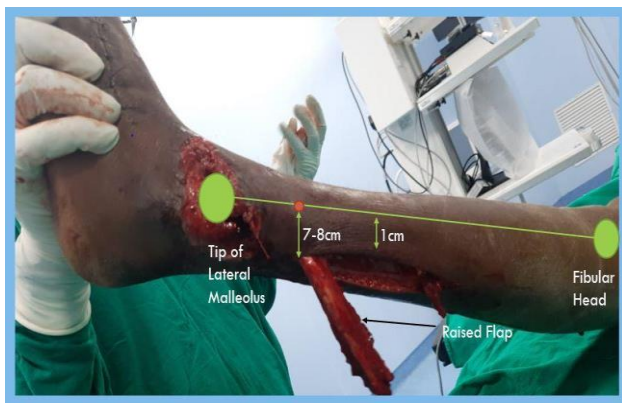
Parameters	Result
<b>Age distribution</b>	8 male (80%), 2 female (20%)
<b>Median age</b>	38 years (range 22-50 years)
<b>Mechanism of injury</b>	RTA- 6 (60%), Accidental fall- 2 (20%), Workplace iInjury- 1 (10%), Assault- 1 (10%)
<b>Location of defect</b>	Lateral malleolus- 4 (40%), lower 1/3rd tibia- 4 (40%), tendoachilles-2 (20%)
<b>Prior orthopedic intervention</b>	External fixator- 2 patients (20%), intramedullary nailing- 1 (10%)
<b>Defect size and range</b>	15 cm <sup>2</sup> (10-20 cm <sup>2</sup> )
<b>Co-morbidities</b>	HTN- 3 (30%), DM- 2 (20%), HTN+DM- 1 (10%)
<b>Flap loss</b>	Partial loss- 1 (10%), no loss- 9 (90%)
<b>Split skin graft uptake</b>	100%- 7 patients (70%), 80%- 3 patients (30%)



**Figure 1: Peroneus brevis muscle anatomy.**



**Figure 3: Case 1 (A) pre-operative defect; (B) immediate intra-operative picture; and (C) post-operative day 10.**



**Figure 2: Skin markings of the peroneus brevis muscle flap with the distally based flap raised.**



**Figure 4: Case 2 (A) pre-operative defect; (B) immediate intra-operative picture; and (C) post-operative day 10.**

## DISCUSSION

All patients were optimised prior to the Surgery and subjected to the same procedure i.e. distally based peroneus muscle flap with split skin grafting over the flap and primary closure of the donor site. All patients were placed in a plaster of paris split post-operatively. Intra-operative condition of the patient was stable and postoperative assessment of the flap was studied under the following headings- flap colour, flap loss either partial or total flap loss, split skin graft uptake, condition of the donor site and flap condition at follow-up. Post-operative complications were grouped under the following headings-skin graft loss and partial/total flap loss.

Flap condition at follow up was noted to be good among all patients included in the study with no patient requiring a followup procedure or readmission into the plastic surgery unit.

All patients had a mean hospital stay of 12±2 days. Flap condition at discharge was noted to be good in all patients. Donor site had healed well at the time of discharge following which suture removal was done. Graft donor sites were healthy and no complications were reported for the same.

All patients had the flap settled well at the time of follow up. Donor site was healthy and the graft donor site healed well. Barring those with external Fixators in situ, all patients had no restriction of range of motion and no functional motor disability.<sup>13</sup>

When compared to previously done studies regarding the same, distally based flaps done in our study had settled well in 100% of cases compared to 80% and partial flap loss in our study was 10% compared to 20%.<sup>14</sup> Donor site and graft uptake were similar across all studies.<sup>15</sup>

Need for secondary procedures in our study was nil as compared to other studies where VAC dressing and/or revision procedure was required.

## CONCLUSION

As per our study, the distally based peroneus brevis muscle flap is a versatile flap able to cover wide range of defects in the lower 1/3rd of the leg and the ankle including the lateral malleolus, anterior tibia, and the Tendoachilles. It's range is limited beyond the Anterior leg and cannot reach the medial malleolus without causing significant tension on the flap pedicle. As the use of the peroneus brevis muscle leads to no long term reduction in function, it is an ideal choice for coverage of soft tissue defects of the lower 1/3rd of the leg and ankle. As the donor site can be primarily closed, it avoids the need for supplementary split skin grafting. Due to the relative ease of raising the muscle flap and its provision of the flap thinning over time to give a more natural

looking cosmetic match, it is a reliable flap for coverage of lower third of leg defects including the lateral malleolus and ankle defects.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: Not required*

## REFERENCES

1. Kneser U, Brockmann S, Leffler M, Haerberle L, Beier JP, Dragu A, et al. Comparison between distally based peroneus brevis and sural flaps for reconstruction of foot, ankle and distal lower leg: an analysis of donor-site morbidity and clinical outcome. *J Plast Reconstr Aesthet Surg.* 2011;64(5):656-62.
2. Bajantri B, Bharathi RR, Sabapathy SR. Wound coverage considerations for defects of the lower third of the leg. *Indian J Plast Surg.* 2012;45(2):283-90.
3. Pinsolle V, Reau AF, Pelissier P, Martin D, Baudet J. Soft-tissue reconstruction of the distal lower leg and foot: are free flaps the only choice? Review of 215 cases. *J Plast Reconstr Aesthet Surg.* 2006;59(9):912-7.
4. Eren S, Ghofrani A, Reifenrath M. The distally pedicled peroneus brevis muscle flap: a new flap for the lower leg. *Plast Reconstr Surg.* 2001;107(6):1443-8.
5. Pers M, Medgyesi S. Pedicle muscle flaps and their applications in the surgery of repair. *Br J Plast Surg.* 1973;26(4):313-21.
6. Lyle WG, Colborn GL: The peroneus brevis muscle flap for lower leg defects. *Ann Plast Surg.* 2000;44:158-62.
7. Ng YH, Chong KW, Tan GM, Rao M. Distally pedicled peroneus brevis muscle flap: a versatile lower leg and foot flap. *Singapore Med J.* 2010;51(4):339-42.
8. Yang YL, Lin TM, Lee SS, Chang KP, Lai CS. The distally pedicled peroneus brevis muscle flap anatomic studies and clinical applications. *J Foot Ankle Surg.* 2005;44(4):259-64.
9. Bach AD, Leffler M, Kneser U, Kopp J, Horch RE. The versatility of the distally based peroneus brevis muscle flap in reconstructive surgery of the foot and lower leg. *Ann Plast Surg.* 2007;58(4):397-404.
10. Lorenzetti F, Lazzeri D, Bonini L, Giannotti G, Piolanti N, Lisanti M, et al. Distally based peroneus brevis muscle flap in reconstructive surgery of the lower leg: Postoperative ankle function and stability evaluation. *J Plast Reconstr Aesthet Surg.* 2010;63(9):1523-33.
11. Taylor GI, Pan WR. Angiosomes of the leg: anatomic study and clinical implications. *Plast Reconstr Surg.* 1998;102(3):599-616.
12. Mathes SJ, Nahai F. Peroneus brevis flap. In: Mathes SJ, Nahai F, eds. *Reconstructive Surgery: Principles, Anatomy and Techniques.* New York: Churchill Livingstone; 1997: 1437-1445.

13. Lyle WG, Colborn GL. The peroneus brevis muscle flap for lower leg defects. *Ann Plast Surg.* 2000;44(2):158-62.
14. Chambers GL, Arsen AN. Characterization of the peroneus brevis muscle for closure of lower extremity defects. A cadaver study and case report. Podiatry Institute, 2002. Available at: [https://www.podiatryinstitute.com/pdfs/Update\\_2002/2002\\_41](https://www.podiatryinstitute.com/pdfs/Update_2002/2002_41). Accessed on 01 September 2023.
15. Bajantri B, Bharathi R, Ramkumar S, Latheef L, Dhane S, Sabapathy SR. Experience with peroneus brevis muscle flaps for reconstruction of distal leg and ankle defects. *Indian J Plast Surg.* 2013;46(1):48-54.

**Cite this article as:** Mohan ARC, Poldas J, Thobbi V. Distally based peroneus brevis muscle flap for the use of reconstruction of lower third defects of leg and ankle. *Int J Res Med Sci* 2023;11:4183-8.