

# Extensor digitorum brevis muscle flap and its donor site morbidity: A case report and review of literature

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**Abstract.** *Introduction:* The dorsum of the foot is one the most challenging areas to be reconstructed, because of the terminal vascularization, the thin skin, and the limited muscle mass. Muscle flaps are the gold standard for treating exposed bones, osteomyelitis, and soft tissue infections. The extensor digitorum brevis digitorum (EDB) flap is a reliable, versatile, and practical locoregional solution for covering small to medium-sized defects in the ankle region. However, its use remains highly controversial because of significant donor-site morbidity. *Case report:* We show a case of an Italian 59-year-old male with a right medial malleolus exposure following a blunt-sprain trauma and covered with an EDB flap. While the flap always remained vital, the patient developed donor-site skin necrosis, requiring surgical debridement with extensor tendons exposure. A dermal substitute (Integra®) was positioned over the extensor tendons, but, due to an infection, antibiotic therapy, dressings and Negative Pressure Wound Therapy (NPWT) were necessary. At the end, a dermal-epidermal graft was used to cover the donor site and the muscle flap. *Conclusion:* As this case report suggests, the EDB flap is a practical option, but its donor-site morbidity is a non-negligible problem, as our literature review underlined. To reduce the complication rate, careful patient selection and pre-operative planning must be performed. ([www.actabiomedica.it](http://www.actabiomedica.it))

**Key words:** muscle flap, osteomyelitis, ankle, pedicled flap, bone exposure

## Introduction

The dorsum of the foot is one the most challenging areas to be reconstructed, because of the terminal vascularization, the thin skin, and the limited muscle mass (1).

Critical structures such as joints, bones, ligaments, and tendons can be exposed easily in the foot and may require prompt coverage with local or distant or free flaps, as the risk of osteomyelitis and possible amputation increases as the bone exposure time passes (2).

Local flaps are faster and technically easier to harvest than free flaps. Diabetes and infections can raise their complication rate, but in young and healthy patients local flaps can be safe (3).

Muscle flaps are the gold standard for the treatment of osteomyelitis, soft tissue infections, and large cavities due to their capacity to obliterate dead spaces, enhance regenerative processes, and increase vascularization and income of antibiotics (4).

The extensor digitorum brevis digitorum (EDB) muscle is a trapezoid-shaped muscle on the dorsum of the foot, supplied by the lateral tarsal artery. It can be a reliable, versatile, and practical locoregional flap to cover small to medium-sized defects in the ankle region extending from the medial to the lateral malleolus, the lower quarter of the leg, and the foot. The EDB muscle flap can be used as an island pedicle or a free flap (5).

However, its use remains highly controversial because of significant donor-site morbidity (6).

This article aims to investigate the donor site morbidity of EDB muscle flap starting from a case and reviewing the literature.

## Case Report

A 59-year-old male was transported to the emergency room following a blunt-sprain trauma of the right foot that happened at the workplace. He was an active smoker, obese (Body Mass Index - BMI 33kg/m<sup>2</sup>), with hypercholesterolemia and hypertension. Following the clinical evaluation and the instrumental tests, a bifocal fibula fracture, tibial-fibular-talar dislocation with posterior malleoli-tibial detachment, and exposure of approximately 2 cm in the anteromedial area of the right ankle were diagnosed. Soft tissue coverage was adequate and there were no peripheral vascular-nervous deficits.

First, the fracture was reduced and stabilized with an ankle bridge external fixator and two intramedullary Kirschner wires in the fibula. Secondarily, the external fixator and K-wires were removed and an internal osteosynthesis was performed with an LCP (Locking Compression Plate) in the right fibula and an inter-syndesmotomic screw (Figure 1).

The patient developed a wound dehiscence over the fibular plate, treated with Negative Pressure Wound Therapy (NPWT) and skin graft (7). Moreover, two surgical debridements of necrotic skin overlying the medial malleolus were necessary, with subsequent bone exposure.

The bone cultures of the medial malleolus were always negative and a pedicled EDB muscle flap was harvested to cover the exposed bone tissue (Figure 2).

The patient's informed consent has been obtained.

While the flap always remained vital, necrosis of the skin above the donor site developed, which required an additional surgical debridement with exposure of the extensor tendons (Figure 3).

For this reason, a dermal substitute (Integra®) (8) was positioned to cover the extensor tendons, but, unfortunately, an infection complicated the situation (Figure 4).

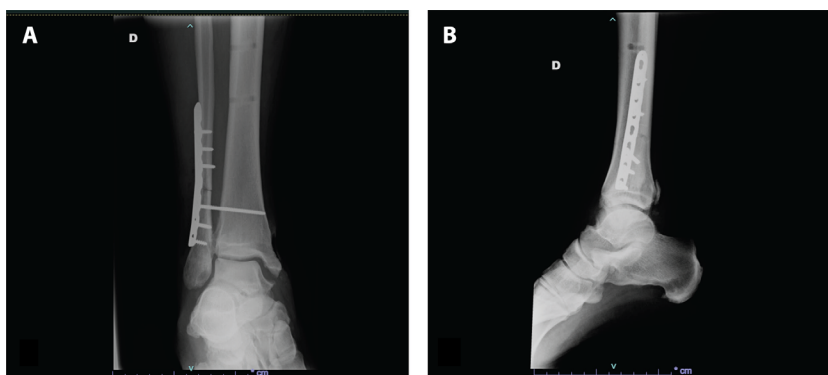
After antibiotic therapy, medications with collagenase ointment and paraffin gauze, and NPWT, a dermal-epidermal graft was used to cover both the lateral wound dehiscence, the muscle flap in the medial malleolar region, and the donor site (Figure 5).

## Discussion

The dorsum of the foot and ankle is one of the most complex areas of lower limbs to be reconstructed due to the terminal vascularization, thin skin, bony prominences, small muscle mass, and lack of local flaps (9).

As our case report suggests, the EDB muscle flap is reliable, solid, and practical: it is easy to harvest, does not require microsurgical skills, and does not cause relevant functional morbidity.

The EDB muscle, the only one with muscular bellies on the dorsum of the foot (10), lies laterally to the



**Figure 1.** X-ray of definitive internal osteosynthesis of the right fibula. A. Antero-posterior view B. Latero-lateral view.



**Figure 2.** Intraoperative view. A. Bone exposure of the medial malleolus after two surgical debridements and NPWT. B. Preoperative markings. The dotted line represents the lateral tarsal artery perceived by Doppler. C. Sutured donor site. A drain was placed to prevent hematoma and it was removed the next day. D. Vital flap covering the medial malleolus bone.



**Figure 3.** Demarcated skin necrosis in the donor site.



**Figure 5.** Donor site after 6 months of follow-up.



**Figure 4.** Infected dermal substitute.

extensor hallucis longus tendon and deep to the tendons of the long toe extensors, inserting on each of the long extensor tendons of the four medial toes.

It is a Type II muscle flap according to Mathes and Nahai Classification with the lateral tarsal artery being its dominant and reliable pedicle, arising from the Dorsalis Pedis Artery at the level or immediately distal to the extensor retinaculum and running deep to the muscle. Veins and nerves usually follow the main arterial pedicle (11).

In the adults, its size is about 6×4.5 cm and it is a dispensable muscle, as the toes can be extended by the long extensor muscles (11).

Woussen et al. consider this flap useful for covering small to medium ankle defects, of approximately 24 cm<sup>2</sup>, with a range of 19 to 34 cm<sup>2</sup> (6).

Although EDB muscle may present some anatomical variations in its heads, tendons, and fascicles, the anatomy of the pedicle is constant, and in patients without severe peripheral artery disease (PAD), a pre-operative exam is not necessary (12).

Contraindications to using this flap include high-energy open trauma or comminuted fractures of the foot because of the possible injury to the EDB muscle, single vessel foot due to peripheral vascular disease, and a recent compartment syndrome (13).

Possible complications of the flap are infection, hemorrhages, wound dehiscence, partial or total flap necrosis, fistula development, and skin graft failure over the flap (11). One limitation of this flap is that can cover an area of approximately 5cm<sup>2</sup> (14).

A non-negligible problem of the EDB muscle flap is donor-site complications, as underlined in different studies in the literature.

This donor-site morbidity was quantified from 10 to 45% by Woussen et al. (6).

Islam Abdelrahman et al. in their work evidenced that 13 out of 64 of the patients developed donor-site complications of which delayed healing was the most common (n = 9), followed by dehiscence (n = 2), and fistulae (n = 2) (11).

As Revol pointed out, extensor tendon adhesions may over time cause foot deformities, claw toes, or mechanical and neurogenic pain if the peroneal nerve branches are damaged. For this reason, some surgeons limit the use of this flap to bedridden or paraplegic patients because of the functional sequelae of its donor site that are “incompatible” with wearing shoes (15).

Torres in his study experienced dehiscence of the donor site in five of 11 patients (45% of patients with viable flaps), probably related to vascular compromise of perforating cutaneous vessels to the skin over the EDB flap after the flap harvesting. Moreover, he associated the magnitude of cutaneous suffering in the donor area with the type of incision to raise the EDB flap: a rectilinear longitudinal skin incision determines less cutaneous vascular strain, while an “L” shaped incision causes more skin suffering due to the extensive

damage to vessels and subdermal vascular system, even if it may facilitate flap harvesting (9).

Jae Kwang Kim et al. have proposed performing a double parallel longitudinal incision to reduce traction on the skin during the operation and to reduce the risk of damaging the lateral tarsal artery. This double incision allows not to expose the EDL tendon. Furthermore, in the opinion of Kim et al., this incision reduces surgery times and skin complications at the donor site (16).

In our clinical case, although the flap always remained vital, the skin of the donor site underwent necrosis, requiring further surgeries. Surgical debridement should be early and aggressive and NPWT is a supportive treatment until the definitive coverage (17).

The EDB muscle is a valid flap. However, to minimize the complication rates, careful patient selection and pre-operative planning are essential. Additionally, an adequate follow-up is crucial in the anterior tibial artery, as this is a preferential site of early arteriosclerosis (18). Furthermore, an orthoplastic approach for the treatment of exposed fractures in the foot and ankle is critical (3).

## Conclusion

The EDB muscle flap can be a useful aid in the coverage of small and medium defects in the medial or lateral malleolar region of the foot. However, the high rate of complications related to the donor site can't be overlooked. For this reason, we believe it is necessary to carefully select the target patient and choose the shape of the incision for harvesting the flap since there is evidence that the incision pattern greatly affects the vascular strain and subsequent survival of the skin covering the harvesting site.

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