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Modified reversed superficial peroneal artery flap in the reconstruction of ankle and foot defects following severe burns or trauma

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ABSTRACT

Objective: Challenges persist in the reconstruction of the ankle and the foot with exposed tendons, joints, and bones as a result of severe burns and trauma. In flap elevation involving the sensitive superficial nerve, the local nerve was always sacrificed to obtain an anesthetic donor site; however, such a procedure introduced the possibility of painful neuromas. In this study, we present a desired clinical application of a modified reversed superficial peroneal artery flap, in which the superficial peroneal nerve is preserved.

Methods: From 2008 to 2015, 12 patients with ankle or foot defects were treated with the modified reversed superficial peroneal artery flap. The defects of the patients were caused by hot liquid scald (one patient), electrical injury (five patients), and trauma (six patients). The flap was utilized for covering defects on the ankle (seven patients) and the foot (five patients). The size of the flaps ranged from 4.0 cm × 6.0 cm to 18.0 cm × 10.0 cm. The superficial peroneal artery was involved in the flap, whereas the superficial peroneal nerve was spared by dedicate dissection. The reverse-flow flap was nourished by the superficial peroneal artery through the terminal peroneal artery perforator.

Results: The obtained outcomes were satisfactory functionally and aesthetically. The flaps in 11 patients survived completely without complications, whereas partial necrosis occurred in a 78-year-old patient when the flap survived a week later during follow up. CT angiography revealed the stenosis of the popliteal artery. The wound healed after interventional treatment involving placing a stent and changing the dressings. Basic functions and configurations were salvaged in all cases. All patients were completely satisfied with the proposed flap and suffered no paresthesia in their lower leg.

Conclusion: Exhibiting beneficial characteristics such as reliable blood supply, favorable thickness, wide rotating arc, and retention of major vessels and the superficial peroneal nerve, the modified reversed superficial peroneal artery flap is useful in the reconstruction of ankle and foot defects that would not cause any hypoesthesia of the foot.

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1. Introduction

The lower extremities are high-risk areas of burns and traumas that easily sustain soft-tissue defects [1]. In view of the paucity of the subcutaneous tissue layer, defects in the ankle and the foot typically involve deep structures. To prevent the infective stage and further damage, burn wounds should be excised, particularly after electrical injuries; however this procedure frequently results in the exposure of tendons and bones [2,3]. Inefficient coverage of these regions contributes to serious deformities and dysfunction. The repair of defects in the ankle and the foot remains challenging to burn surgeons because post-burn contracture aggravates the problem.

The application of skin grafts and the changing of wound dressing seldom results in acceptable functional and aesthetic outcomes. Advances in anatomical studies and surgical techniques have led to the development of a wide range of alternative flaps. The application of free flaps requires microsurgery, which necessities long operating hours and sophisticated devices. The harvest of distally based island flaps in main vessels introduces high risks of acute limb ischemia. In the use of the traditional superficial peroneal neurocutaneous flap, the superficial peroneal nerve is always sacrificed [4]. The modified reversed superficial peroneal artery flap is a perforator flap that uses the superficial peroneal artery as the pedicle. The flap is nourished by the superficial peroneal artery and the superficial peroneal nerve accessory artery to which it contributes. The reverse perfusion is supplied by the terminal peroneal artery perforator without the harvesting of major vessels. In this study, we modified the harvesting process of the flap and left intact the superficial peroneal nerve to avoid hypoesthesia of the foot. The advantages of this modified superficial peroneal artery flap include reliable blood supply, favorable thickness, wide rotating arc, and retention of major vessels and the superficial peroneal nerve. Our objective is to present our experience in raising this flap for ankle and foot defects resulting from severe burns or trauma.

2. Materials and methods

The modified reversed superficial peroneal artery flap was performed on 12 patients with ankle and foot defects who were hospitalized from 2008 to 2015. Of these patients, 10 were men and two were women, with a mean age of 36 years (range, 6–78 years). Their wounds were caused by electrical injury (five cases), hot liquid scald (one case), and trauma (six cases). The flap was employed to cover defects in the ankle (six cases), the foot (five cases), or both (one case). The size of the flaps ranged from 4.0 cm × 6.0 cm (minimum) to 18.0 cm × 10.0 cm (maximum) (Table 1).

2.1. *Relevant anatomy*

The superficial peroneal artery is a septocutaneous perforator arising from the anterior tibial artery approximately 5 cm distal to the lower border of the fibular head. As shown in Fig. 1, the superficial peroneal artery is typically located in the intermuscular septum between the peroneus longus and the extensor digitorum longus [5]. Descending along the superficial peroneal nerve, the superficial peroneal artery courses through the anterior intermuscular septum for a distance of 6.5–17.3 cm. The superficial peroneal artery contributes to the superficial peroneal nerve accessory artery, and it constantly anastomoses with the terminal peroneal artery perforator approximately 5 cm above the lateral malleolus. After piercing the intermuscular septum, it runs beneath the deep fascia, and then penetrates the fascia 16.1–26.2 cm from the fibular head. The superficial peroneal artery gives off 1–4 cutaneous branches before nourishing the anterolateral aspect of the skin in the distal 1/3 of the leg.

2.2. *Surgical technique*

The size of the defect was measured under general anesthesia after complete debridement of the necrotic tissue in recipient position. With the patient in supine position, we drew a line from the anterior fibular head to the anterior lateral malleolus to indicate the general location of the anterior intermuscular septum. The flap design was centered on the line so that superficial peroneal artery was located in the axis of the flap.

Preoperative Doppler identification was employed in locating the superficial peroneal artery and the terminal peroneal artery perforator. The size of the flap was intended to be slightly larger than the debrided defect. In our series cases, the length-to-width ratio was less than 1.5, thereby ensuring that the pedicle had a stable blood supply.

Table 1 – Demographic data of the patients who underwent modified reversed superficial peroneal artery flap.

Patient no.	Gender	Age (years)	Cause of injury	Wound location	Flap size (cm^2)	Flap outcome
1	Male	17	Electrical injury	Ankle	6.0 × 11.0	Complete survival
2	Male	78	Trauma	Foot	5.0 × 6.0	Partial necrosis
3	Male	17	Electrical injury	Ankle	7.0 × 8.0	Complete survival
4	Male	17	Electrical injury	Ankle	4.0 × 6.0	Complete survival
5	Female	46	Trauma	Ankle	19.5 × 6.5	Complete survival
6	Female	39	Trauma	Ankle	6.0 × 6.0	Complete survival
7	Male	45	Trauma	Ankle	10.0 × 8.0	Complete survival
8	Male	59	Trauma	Foot	10.0 × 9.0	Complete survival
9	Male	6	Hot liquid scald	Foot	6.5 × 5.0	Complete survival
10	Male	41	Electrical injury	Foot and ankle	18.0 × 10.0	Complete survival
11	Male	36	Trauma	Foot	15.0 × 7.0	Complete survival
12	Male	49	Electrical injury	Foot	17.0 × 7.0	Complete survival