

Bilateral Knee Soft-tissue Reconstruction after High-voltage Electrical Burn Injuries

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Summary: This is the case of a 21-year-old man who had extensive and bilateral knee soft-tissue damage after a high-voltage electrical discharge. In its reconstruction, we simultaneously performed the pedicled medial sural artery perforator flap. Even though mild complications took place, this alternative proved helpful and reliable, providing an easily adjustable skin island and allowing for the patient's rapid rehabilitation and a satisfactory aesthetic outcome. Although this flap's reconstructive potential is known in other etiologies, the present report outlines its substantial potential in the case of electrical burn injuries, as it has barely been recognized before. (*Plast Reconstr Surg Glob Open* 2023; 11:e4854; doi: [10.1097/GOX.0000000000004854](https://doi.org/10.1097/GOX.0000000000004854); Published online 8 March 2023.)

High-voltage electrical burn injuries often result in extensive skin and soft-tissue damage, particularly in areas of muscle insertions, which are prone to harm due to their condition as electrical resistance transition zones. As part of them, the knee is a region that often gets involved. It is a complex structure involving two joints and a conjunction of structures that, as a whole, play a fundamental role in limb stability and gait biomechanics.¹

The medial sural artery perforator flap (MSAPF) is based on septocutaneous perforators originating from the medial sural artery.² The current report illustrates our experience of employing the pedicled MSAPF bilaterally and simultaneously on the reconstruction of the knee soft-tissues in a patient who experienced electrical burn injuries.

CASE REPORT

A 21-year-old man experienced an electrical discharge followed by a 2-m fall after handling high-voltage line cables under unknown circumstances. He was taken immediately to the closest healthcare setting and received initial care, including cardiopulmonary resuscitation.

A week later, he was referred to our hospital; his condition was critical, requiring mechanical ventilation and

vasopressors. In the initial assessment, a history of illicit drug abuse was established. He had mixed-depth second-degree and third-degree burn injuries on his anterior thorax, upper abdomen, forearms and right-hand volar aspect. Nonetheless, the most striking injuries were on his lower limbs, which comprised both patellar regions (Fig. 1). The admission diagnosis was mixed-depth electrical burn injuries compromising 15% of his total body surface area.

Firstly, escharectomies were performed over the affected areas, followed by coverage with allografts on the fifth and 11th day postinjury. Meanwhile, negative pressure wound therapy was applied to the patient's lower limbs. Subsequent surgical debridements were required until stable granulation tissue was accomplished. Then, local fasciocutaneous advancement flaps were used to cover both forearm injuries and patellar soft-tissue defects on the 17th day postinjury. Nevertheless, the defect's dimensions were still (length × width) 8 cm × 12 cm in his right knee and 16 cm × 13 cm in his left knee, with exposed joint surfaces. Therefore, we chose the pedicled MSAPF to address this issue.

On postinjury day 20, the reconstructive procedure was performed. It occurred simultaneously on both lower limbs and was completed without complications (Fig. 2). Skin island dimensions were 12 cm × 10 cm for the right flap and 18 cm × 14 cm for the left flap. Bone and critical structures were completely covered. The perforator vessels were located in the proximal third of the line that joins the popliteal fossa with the medial malleolus, just above the medial gastrocnemius muscle. At least two

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Fig. 1. Mixed-depth second-degree and third-degree burn injuries comprising both patellar regions.

perforators were added to the pedicle. The initial incisions were made up to the subfascial plane. Next, the perforator vessel was identified randomly because no preoperative Doppler scan or arteriography was carried out due to the lack of availability. Next, the perforator vessels were dissected intramuscularly, following their retrograde path to the medial sural artery. To provide a more robust blood supply and venous drainage to the flap, the lesser saphenous vein and the sural nerve were dissected and integrated into the 5 cm width pedicle. Then, the pedicle was dissected to achieve enough length and arc of rotation required to cover the defect. Ultimately, the flap was carefully lifted with its perforator vessels and transposed in a tunneled fashion through the lateral aspect of the knee into its anterior surface. Local advancement flaps and split-thickness skin grafts covered the sural donor sites.

Flap surveillance took place for over a month while the patient continued to be treated for infectious and metabolic



Fig. 2. The pedicled MSAPF dissection over the gastrocnemius muscle and inset over the soft-tissue defects.

complications such as hyponatremia, hospital-acquired pneumonia, and *Candida parapsilosis* bloodstream infection. In the second week, the left flap had 5% necrosis over the medial aspect due to the large size of the skin island, which limited the perfusion of the peripheral regions, and over 20% of the left donor site skin graft was lost, exposing the left Achilles tendon. Nonetheless, both issues were managed with local advancement flaps. Finally, knee flexion was allowed in the fourth postoperative week, and the patient started his physical rehabilitation. After roughly 3 months of inpatient treatment, he was discharged.

Follow-up took place after 1, 6, and 12 months. It revealed the complete vitality of both flaps and proper healing of the donor sites (Fig. 3). Furthermore, the patient could walk without external aid, was engaged with his rehabilitation process and was satisfied with the aesthetic result after all the interventions. (See Video [online], which shows 12 month follow-up outcomes after the bilateral and



Fig. 3. Twelve month follow-up outcomes after bilateral knee soft-tissue reconstruction. The patient regained his normal gait and arc of motion in the knees. A, Patient standing. B, Patient sitting.

simultaneous knee soft-tissue reconstruction due to high-voltage electrical burn injuries, where the pedicled medial sural artery perforator flap was employed.) However, among the limitations in the treatment of the patient, the lack of judicious assessment of peripheral neuropathy or burn-related nerve pain is worth mentioning.

DISCUSSION

When an electrical current makes contact with the human body, it preferentially transits along low-resistance pathways, passing through soft tissue, contacting high-resistance bone, and traveling along the body until it exits to the ground.³ The treatment of electrical injuries carries challenges like extensive soft-tissue damage, which is commonly larger than apparent. Moreover, vascular injury to nutrient arteries and damage to the intima and media can result in thrombosis³ and impairment of wound healing mechanisms.⁴ All of these factors provide a greater chance of complications and flap failure. Thus, reconstruction is more arduous than in other etiologies, such as trauma, infection, or tumor resections.

In this case, the uncommon bilateral compromise caused by the exit electrical wounds portrays the immense harm this etiology can deliver to lower limb soft tissues. The reconstruction of a bilateral defect in this scenario is a challenge even for most experienced surgeons, whose choice must deliver a pliable but stable soft tissue, allowing the joint's full range of motion, patient early mobilization, and rehabilitation after interventions.⁵

The gastrocnemius flap is well-known as the workhorse flap for knee and upper leg soft-tissue reconstruction.⁶ It is a muscular or myocutaneous pedicled flap useful in case of infection or when dead space obliteration is required. However, among its drawbacks, its limited arc of rotation, bulk appearance, and donor site morbidity are worth mentioning.

Although it is a reliable alternative, it does not provide the best outcomes regarding functionality and aesthetics.

Therefore, assessing our patient's options, we considered the pedicled MSAPF a superior alternative. Although one would think it risky to perform the reconstruction simultaneously in both lower limbs, the pedicled MSAPF proved reliable in this case. It provided easily adjustable island designs, a superior pedicle length, and an arc of rotation, allowing the coverage of the left knee's superolateral aspect. Although donor site complications occurred, they were smoothly addressed with simple techniques. In terms of cosmesis, it granted thin, malleable, and adaptable skin, restoring the contour of both knees. Most remarkably, it allowed the patient's prompt commencement of functional rehabilitation. While the pedicled MSAPF's reconstructive potential has been granted in other etiologies,^{7,8} the present report outlines its significant potential in the case of electrical injuries, which has scarcely been acknowledged before.⁹

CONCLUSIONS

Although extensive knee soft-tissue damage has been documented in cases of electrical injuries, a bilateral compromise is exceptional, as is the current case described. To address this challenging task, we used the pedicled MSAPF, which proved to be a reliable alternative, providing adaptable skin, restoring the contour of both knees, and allowing for the patient's prompt rehabilitation start. Therefore, it is worth being known by reconstructive surgeons handling patients under these circumstances.

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