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Microsurgical Reconstruction of Tibial and Common Peroneal Nerve Defects Following High-Voltage Electrical Injury in a Pediatric Patient: A Case Report

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Abstract

High-voltage electrical injuries are associated with extensive soft tissue destruction, neurovascular damage, and a high risk of limb loss. Limb salvage in pediatric patients presents an additional challenge due to the long regenerative period required for functional recovery. We present the case of an eight-year-old child who sustained a severe high-voltage electrical burn to the lower extremity. Initial evaluation revealed extensive soft tissue loss with destruction of both the tibial and common peroneal nerves, while the major arterial and venous circulation remained intact. Due to the severity of the injury and the risk of progressive tissue erosion, limb amputation was recommended. Upon presentation to the Plastic and Reconstructive Surgery Department at Kuzanov Clinic, a limb-salvaging approach was proposed. The damaged tibial and common peroneal nerves were reconstructed using autologous cutaneous nerve grafts harvested from a donor site. Three cable grafts were used to reconstruct the tibial nerve and two cable grafts were used for the common peroneal nerve, with meticulous fascicular alignment under microscopic magnification. Soft tissue coverage was achieved using a free thoracodorsal flap with microvascular anastomosis between the flap vessels and recipient femoral vessels. The patient was discharged after seven days and continued rehabilitation on an outpatient basis. Nerve regeneration progressed at an estimated rate of approximately 1 mm per day. One year following surgery, complete functional recovery of the reconstructed nerves was achieved, as confirmed by electromyography (EMG), nerve conduction studies, and clinical functional assessments, including motor strength, sensory recovery, and gait evaluation, demonstrating the potential of microsurgical limb salvage in severe pediatric electrical injuries.

Categories: Plastic Surgery, Pediatric Surgery, Orthopedics
Keywords: cable nerve grafting, electrical burn, free flap reconstruction, high-voltage electrical injury, isolated common peroneal nerve injury, limb salvage, pediatric microsurgery, peripheral nerve reconstruction, thoracodorsal flap, tibial nerve injury

Introduction

High-voltage electrical injuries are among the most devastating forms of trauma encountered in reconstructive surgery due to their ability to cause extensive soft tissue destruction and deep injury to neurovascular structures [1].

Historically, severe electrical injuries with extensive tissue destruction were frequently managed with amputation because of the risks of infection, progressive tissue necrosis, and poor functional outcomes [2]. However, advances in microsurgery, nerve reconstruction, and free tissue transfer have expanded the possibilities for limb preservation.

Peripheral nerve reconstruction is particularly important in pediatric patients, whose greater regenerative potential may permit substantial functional recovery when appropriate surgical techniques are employed [3]. Successful outcomes depend upon meticulous fascicular alignment, adequate vascularized soft tissue coverage, and comprehensive postoperative rehabilitation.

This case report describes successful limb salvage in an eight-year-old child following a high-voltage electrical burn with complete disruption of the tibial and common peroneal nerves. Reconstruction was accomplished through cable nerve grafting and free thoracodorsal flap transfer, resulting in complete neurological recovery one year postoperatively.

Case Presentation

An eight-year-old male sustained a high-voltage electrical injury to the lower extremity. On initial assessment, the injury was characterized by extensive soft tissue loss with severe damage to both the tibial and common peroneal nerves. Notably, the major arterial and venous structures of the limb remained intact.

Given the magnitude of tissue destruction and the anticipated risk of progressive necrosis and irreversible functional loss, primary amputation was initially recommended by the referring team (Figures *1*-*3*).

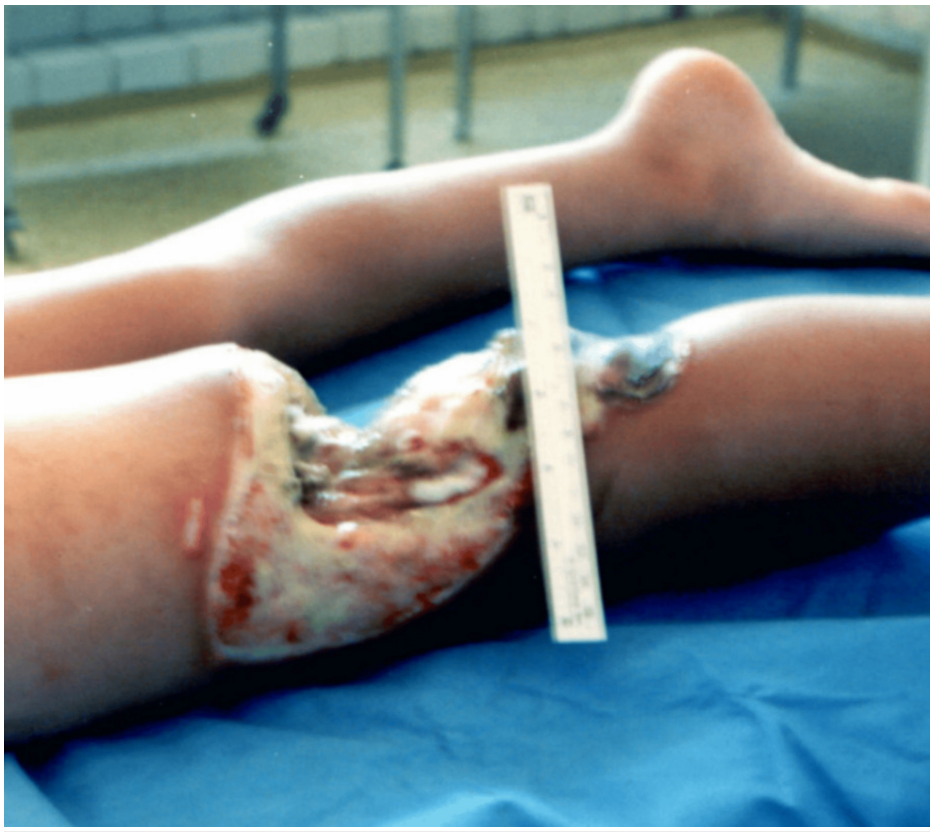


FIGURE 1: Preoperative appearance of the lower extremity demonstrating the full extent of the high-voltage electrical injury.



FIGURE 2: Close-up view of the soft tissue defect illustrating full-thickness tissue loss, with necrotic muscle and devitalized subcutaneous tissue. A ruler is included for scale.

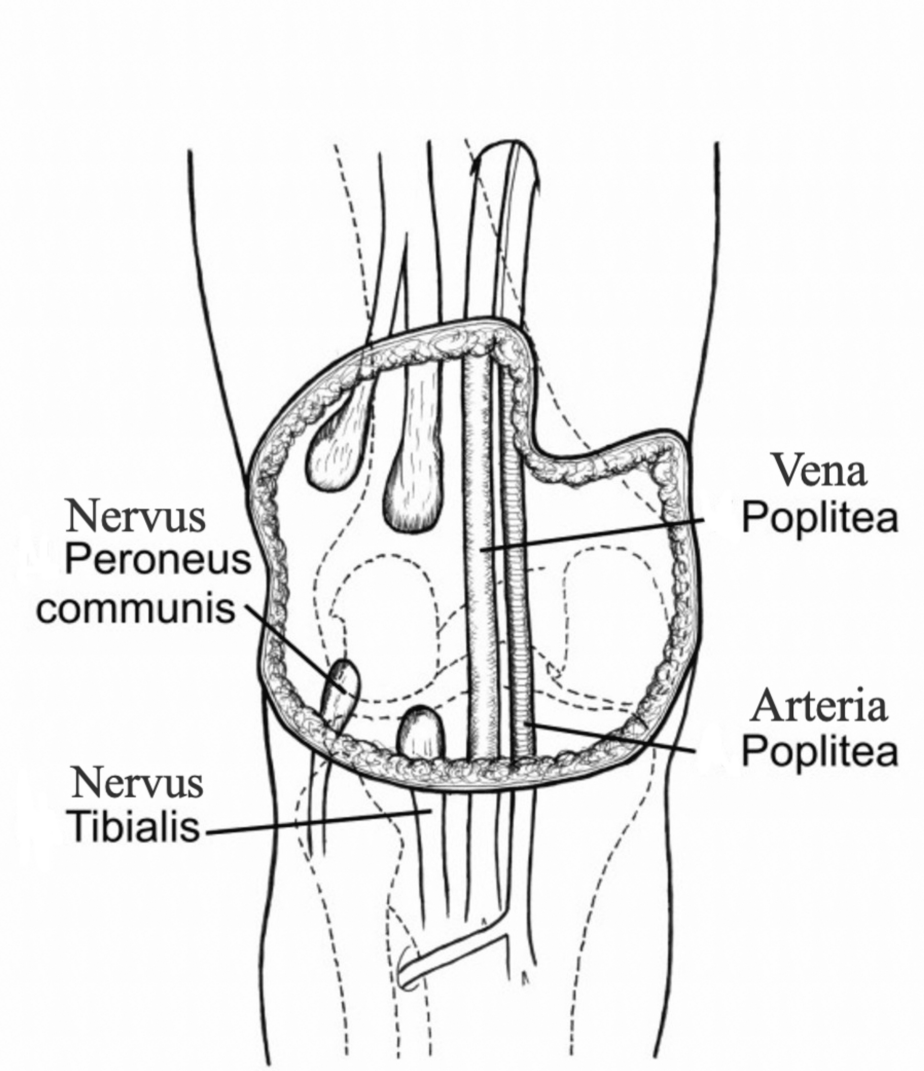


FIGURE 3: Schematic illustration of the anatomical zone of injury at the level of the popliteal fossa, depicting the spatial relationship between the tibial nerve, common peroneal nerve, popliteal artery, and popliteal vein within the area of tissue destruction.

Original drawing by Dr. Alexander Kutubidze, used with permission.

Following transfer and evaluation at Kuzanov Clinic, a multidisciplinary decision was made to pursue a limb-salvage strategy.

Nerve reconstruction

Following debridement of the damaged nerve segments, the resulting defects measured approximately 7-8 cm in both the tibial and common peroneal nerves. Autologous sural nerve grafts were harvested and utilized as cable grafts for reconstruction of the damaged peripheral nerves. Under operative microscopic magnification, individual fascicular groups were meticulously identified and aligned with their corresponding recipient fascicles within both the tibial and common peroneal nerves, with the aim of optimizing axonal regeneration and end-organ reinnervation. Reconstruction of the tibial nerve required three cable grafts, while the common peroneal nerve was reconstructed using two cable grafts. Nerve coaptation was performed using 8-0 Prolene sutures, and fascicular continuity was restored throughout (Figure *4*).

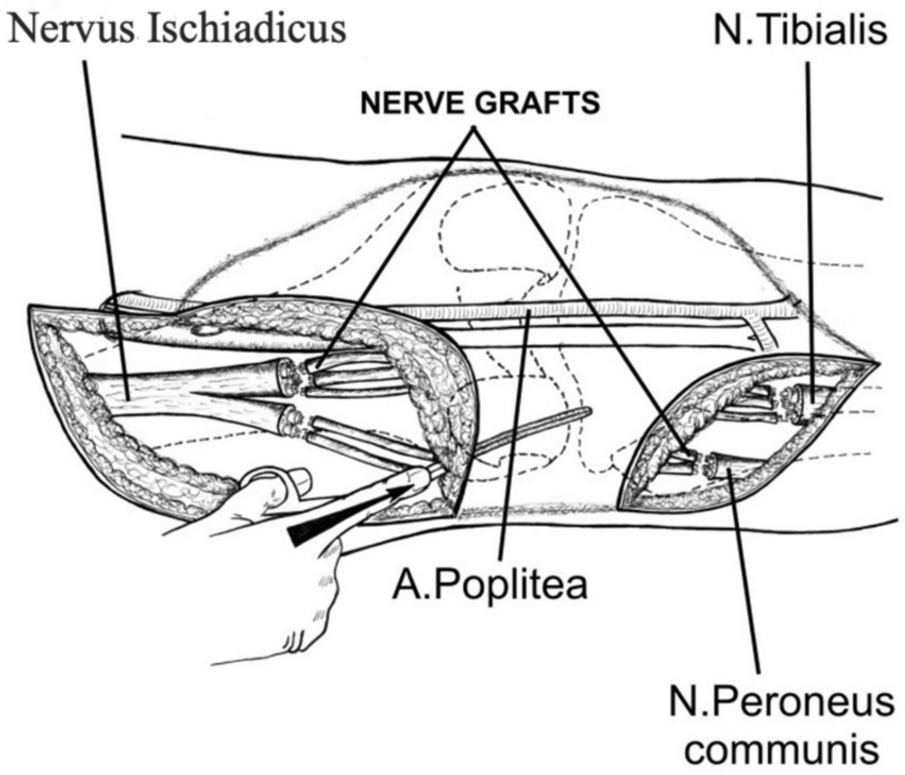


FIGURE 4: Schematic illustration of sural nerve cable graft reconstruction of the sciatic nerve divisions. Multiple cable grafts (nerve grafts) are depicted bridging the gap between the proximal sciatic nerve (nervus ischiadicus) and the distal tibial (N. tibialis) and common peroneal (N. peroneus communis) nerve stumps. The popliteal artery (A. poplitea) is shown intact within the zone of injury, with fascicular coaptation performed under microsurgical magnification at both proximal and distal repair sites.

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Soft tissue coverage

Following completion of nerve reconstruction, a free thoracodorsal flap was elevated and transferred to resurface the soft tissue defect. Microvascular anastomoses were performed between the thoracodorsal artery and the femoral artery, and between the thoracodorsal vein and the femoral vein, utilizing an end-to-side configuration to preserve native distal perfusion. Vascular anastomoses were completed using 9-0 Prolene sutures under continuous microscopic visualization. Flap perfusion was confirmed intraoperatively upon release of vascular clamps, with prompt capillary refill and satisfactory Doppler signal at the pedicle (Figure *5*).

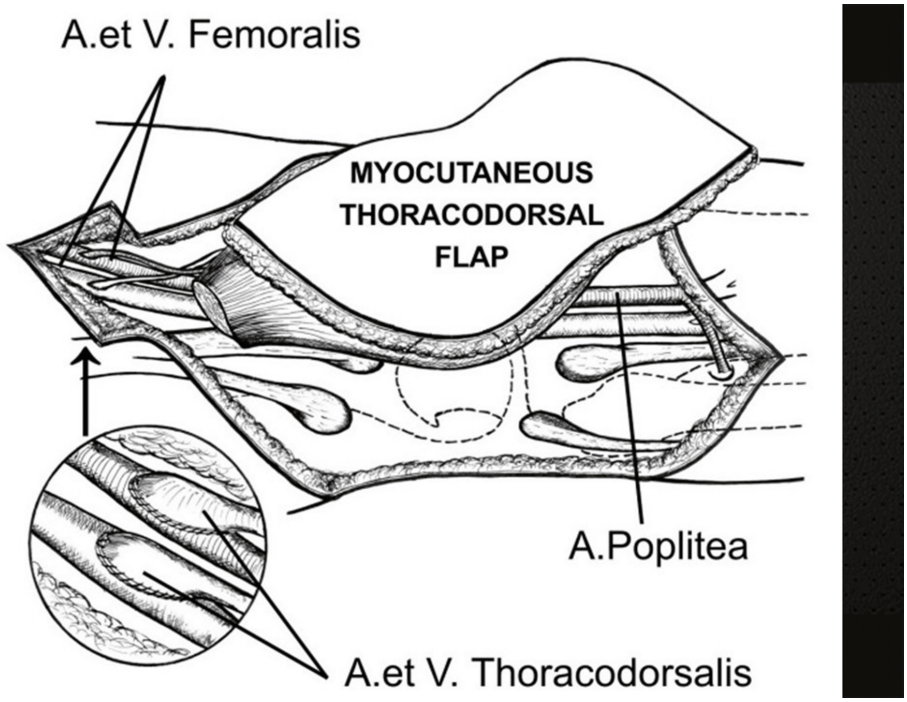


FIGURE 5: Schematic illustration of free myocutaneous thoracodorsal flap transfer for soft tissue reconstruction. The flap is shown inset into the popliteal defect, with the thoracodorsal vascular pedicle (arteria et vena thoracodorsalis) anastomosed end-to-side to the femoral vessels (arteria et vena femoralis). The inset magnification depicts the completed microvascular anastomosis. The intact popliteal artery (A. poplitea) is demonstrated coursing beneath the flap, confirming preserved native limb perfusion.

Original drawing by Dr. Alexander Kutubidze, used with permission.

Postoperative course and outcome

The patient was discharged after seven days of inpatient care and enrolled in a structured outpatient rehabilitation program. Postoperative rehabilitation focused on restoring joint mobility, muscle strength, and functional ambulation, with particular attention to the recovery of tibial and common peroneal nerve function. Serial clinical assessments during follow-up visits demonstrated progressive return of motor and sensory function in both tibial and common peroneal nerve distributions. Neurological recovery was evaluated through electromyography (EMG) and clinical functional assessments, including evaluation of ankle plantarflexion, dorsiflexion, muscle strength, sensory function, and gait. The one-year follow-up assessment demonstrated substantial functional recovery, supported by the patient's ability to ambulate independently and perform an active unilateral heel rise on the reconstructed limb. At one year postoperatively, substantial functional recovery had been achieved, with restoration of independent ambulation and clinically meaningful lower-extremity function (Figures *6*-*8*).



FIGURE 6: Postoperative appearance of the reconstructed lower extremity following free thoracodorsal flap transfer. The flap is well-integrated with satisfactory contour restoration. Healed scars from the surgical approach and donor site are visible.



FIGURE 7: One-year postoperative functional outcome. Anteroposterior view demonstrating symmetric limb alignment, preserved muscle bulk, and no evidence of atrophy or deformity, consistent with successful motor reinnervation.



FIGURE 8: Functional assessment at one year postoperatively. The patient demonstrates active unilateral heel rise on the reconstructed limb, confirming complete recovery of tibial nerve motor function and restoration of normal lower extremity biomechanics.

Discussion

The decision between limb salvage and amputation remains one of the greatest challenges in reconstructive surgery. Although amputation may provide a predictable solution in severe injuries, preservation of the limb remains preferable whenever meaningful functional recovery can reasonably be expected [4].

Successful reconstruction in this setting requires simultaneous addressing of two distinct but interdependent problems: durable soft tissue coverage and restoration of neural continuity. Failure to achieve either compromises the other. The free thoracodorsal flap, with its reliable vascular anatomy and generous tissue volume, was ideally suited to resurface the defect while creating a well-vascularized local environment conducive to nerve regeneration [5]. Placement of the microvascular anastomoses to the femoral vessels in an end-to-side configuration preserved native distal perfusion, which is a critical consideration when the popliteal axis remains intact.

The reconstruction of both the tibial and common peroneal nerves using autologous cable grafts posed the central technical challenge of this case. The use of multiple cable grafts allowed fascicular group matching across the defect, maximizing the proportion of regenerating axons directed toward appropriate end-organ targets [6]. This is particularly relevant for the common peroneal nerve, where misdirected regeneration may result in persistent functional deficit even when axonal regrowth is otherwise successful.

The complete functional recovery achieved at one year in this patient likely reflects a convergence of several favorable factors. Beyond the well-established regenerative advantages of pediatric nervous systems, the intact vascular supply ensured optimal perfusion of both the grafts and the target musculature throughout the regeneration period. Equally, the absence of significant delay between injury and definitive reconstruction likely minimized the degree of distal Wallerian degeneration and end-organ denervation atrophy.

This case illustrates that in carefully selected pediatric patients, even extensive high-voltage injuries with combined nerve and soft tissue destruction need not be considered unsurvivable for the limb. When vascular integrity is preserved, and microsurgical expertise is available, a staged, anatomy-respecting reconstructive approach can yield outcomes that would be unattainable through amputation alone.

Conclusions

This case report demonstrates successful limb salvage following severe lower-extremity injury through combined microsurgical nerve reconstruction and free tissue transfer. Reconstruction of the tibial and common peroneal nerves using autologous cable grafts, together with coverage by a free thoracodorsal flap, resulted in complete functional recovery one year after surgery. These findings suggest that complex microsurgical reconstruction should be considered before amputation in pediatric patients with preserved vascular integrity and reconstructable peripheral nerve injuries.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Ketevan Kuzanov, Aleksandre Kuzanov

Acquisition, analysis, or interpretation of data: Ketevan Kuzanov, Aleksandre Kuzanov, Ivane Kuzanov

Drafting of the manuscript: Ketevan Kuzanov

Critical review of the manuscript for important intellectual content: Ketevan Kuzanov, Aleksandre Kuzanov, Ivane Kuzanov

Supervision: Aleksandre Kuzanov, Ivane Kuzanov

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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