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Electrical Injury to Both Upper Limbs with Bilateral Shoulder Disarticulation

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Abstract: **Original Research**
The severity of tissue damage caused by high-voltage electrical injuries to the limbs often complicates the management of such burns. Repair procedures are sometimes ineffective, and amputations become unavoidable. We report the case of a young patient who sustained high-voltage electrical injuries to both upper limbs, resulting in bilateral shoulder disarticulation.
Keywords: Electrical injury, high voltage, disarticulation, shoulders.

INTRODUCTION

High-voltage electrical burns are particularly devastating. The extent of damage is unpredictable, progressive, and the visible skin necrosis often underestimates the underlying tissue injury. Managing such injuries, especially when they affect the limbs, poses a significant challenge for plastic surgeons. These injuries are predominantly occupational, with a clear male predominance. They often result in severe burns with massive tissue destruction and can lead to life-threatening complications, such as cardiorespiratory arrest, ventricular fibrillation, and acute renal failure. The severity of tissue damage makes the management of these burns extremely difficult. Debridement, escharotomy, and fasciotomy procedures are sometimes ineffective, and amputations become inevitable.

We present the case of a young patient who sustained high-voltage electrical injuries to both upper limbs, resulting in bilateral shoulder disarticulation.

Case Report

A 36-year-old male with no significant medical history sustained a true electrical burn five days prior (likely due to copper cable theft). He did not receive immediate acute care and was later brought by his family to the Laayoune Regional Hospital Center, where he was hospitalized for 48 hours and underwent preliminary tests before being transferred to the Marrakech University Hospital without prior regulation.

Admission Examination:

- **General Condition**: The patient was tachycardic, hypertensive, slightly lethargic, afebrile, with normal oxygen saturation and respiratory rate.

- **Local Examination**: Circumferential burns with extensive tissue necrosis were observed on both upper limbs. The total burned surface area was estimated at 18% (third-degree burns). Signs of ischemia in

Table 1: Admission biological findings

bilan	a l'admissiom	j 1 post op	j15 post op
ECG	tachycardie sinusal	normal	normal
HB	9,9	8,4	10,4
GB	50880	30000	12000
PLQ	100000	15000	220000
NA+	125	129	135
K+	5,7	4,8	4,7
UREE	0,52	0,42	normal
CREAT	8,7	8,7	mormal
CRP	252	180	34
CPK	73711	55060	200
LDH	2027	1400	350
ASAT	X30 normal	X30 normal	X2 normal
ALAT	X10 valeur normal	X10 valeur normal	X2 normal
troponine	normal	normal	normal

- The patient was promptly admitted to the intensive care unit. Hydro-electrolytic resuscitation and analgesia were initiated. Hydration with urine alkalinization was continued, aiming for a urine output of >1 mL/kg/h. The patient was placed on imipenem and amikacin antibiotic therapy.
- It became clear that limb salvage was impossible. After obtaining consent from the patient and his family, he was taken to the operating room, where bilateral shoulder disarticulation was performed.

both limbs were noted, and motor function in the hands and elbows was absent (Fig 1).

- **Exit Wound**: Located on the external aspect of the left thigh.
- **Biological Findings**: See Table 1.

The postoperative course was uneventful (Fig 2).

- The psychological impact on the patient was significant, necessitating frequent psychiatric support. After several weeks of hospitalization, the patient was discharged to a rehabilitation center for bilateral prosthetic fitting.

Fig 1: **Admission appearance**

Fig 2: **Bilateral shoulder disarticulation**

DISCUSSION

Approximately 9% of burns are electrical in origin, with frequencies ranging from 2-4% in Europe to 6.5-17% in China. Although their incidence is low, they carry high morbidity and mortality rates. Initially, electrical burns may appear to affect only small skin areas, but the true tissue damage becomes evident later. The burned area is often much larger and deeper than it initially appears. The extent of injury depends on the current, tissue resistance, and exposure time.

Electrical current causes microcirculatory damage, endothelial integrity loss, and fluid retention in the extravascular space, leading to edema and reduced blood flow in the injured limb. This explains the progressive nature of necrosis. High-voltage electrical burns often affect the extremities, as they are typically the entry and exit points for the current. Limbs, being narrow body segments, concentrate the current in small tissue volumes, resulting in increased tissue destruction.

The low resistance of neurovascular tissues makes nerves and blood vessels the preferred pathways for electrical current. Edema severely compromises blood supply to the affected tissues, exacerbating pre-existing injuries. Additionally, myoglobin and hemoglobin from damaged muscles and red blood cells can lead to myoglobinuria and even renal failure in cases of low renal blood flow and urine output.

The management of high-voltage electrical burns remains challenging despite therapeutic advances over the past three decades. Local inflammatory reactions are often severe, leading to compartment syndrome and cellular necrosis in the limbs. Early fasciotomy (within six hours) is crucial in cases of ischemia. Early fasciotomy (required in 10-50% of cases) is a marker of burn severity and has been shown to preserve tissue perfusion and reduce the need for amputations. Some advocate for early vascular grafting to salvage distal ischemia. However, high-voltage current often causes significant vascular wall damage, particularly to the intima, leading to extensive and recurrent thromboses that worsen tissue damage and compromise revascularization efforts.

Angiography may be useful for assessing vascular status but can worsen renal function. Angio-MRI is preferable, as it can detect vascular morphological changes and thromboses. Before surgical exploration, it is often difficult to predict the extent of deep tissue necrosis. MRI has proven valuable in detecting and assessing the extent of deep muscle necrosis, aiding surgical planning. However, in some cases, tissue damage is immediately severe and irreversible, making repair efforts futile and necessitating amputation, as in our patient. The literature reports amputation rates of 24-49% in such cases. Amputations should be delayed as long as the patient's condition allows. When necessary, the level of amputation is determined by the extent of injury and prosthetic fitting possibilities. In our patient, bilateral shoulder disarticulation was unavoidable. Proximal amputations complicate prosthetic fitting and reduce patient acceptance.

These traumatic injuries are often accompanied by significant psychological sequelae, including depression, neurotic or psychotic manifestations, and memory disorders, typically associated with post-traumatic stress disorder, which hinders socio-professional reintegration. Family support and psychological counseling during hospitalization and rehabilitation are crucial for facilitating patient reintegration and improving long-term outcomes.

CONCLUSION

The management of electrical burns to the extremities should include urgent fasciotomy, excision of necrotic tissue, and amputation of non-viable limbs. Amputation may be the only solution when vital or functional prognosis is at risk.

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