

High-Voltage Electrical Burns of Children (A Seven Cases Report)

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Article History

Received: 14.10.2018

Accepted: 23.10.2018

Published: 30.10.2018

DOI:

10.36347/sjmcr.2018.v06i10.028



Abstract: High-voltage electrical accidents (HVEA) cause deep scalds by the Joule effect along the vasculo-nervous axis between the entry and exit points, which are the seat of lacerating lesions. A series is reported of six cases of HVEA admitted to the service of plastic surgery and burns unit, Children Hospital, Rabat, Morocco, in which the epidemiological, clinical, and therapeutic characteristics are studied. All the patients were children, male (mean age, 11 yr). In 60% of the cases, the scalds were secondary to contact with the distributors of electricity. The burn surface area was less than 20% in 66% of the cases. The treatment of electro-thermic lesions required iterative interventions with amputation of necrotic member segments in 33% of cases, with sequelae marked by disabling functional after-effects. The prevention of HVEA remains fundamental.

Keywords: Electric Burn, High-Voltage, Child.

INTRODUCTION

Electrization refers to all physiopathological manifestations related to the action of electric current on the human body, while the more commonly used term of electrocution corresponds to death by electrization [1]. High voltage electrical accidents (> 1000 V) are responsible for severe and severe tissue burns and are characterized by an insidious and torpid evolution

In our present work, we report a retrospective study at the Pediatric Plastic Surgery and Burns Department at the Children's Hospital at IBN SINA CHU in Rabat and interesting a series of seven children.

MATERIALS & METHODS

From January 2014 to September 2017, 7 patients with high-voltage electric burns were admitted to the pediatric plastic surgery department at Rabat Children's Hospital. The study analyzed the age, sex, mechanism, seat, depth and extent of the burn, as well as the different treatment techniques.

RESULTS

All patients were male children, with an age range of 7 years and 14 years and an average age of 11 years. In 4 cases, the burns were secondary to contact with electricity distributors, in 2 cases secondary to contact with an electric pole where the two children wanted to ride, causing their fall. There is contact with a high voltage wire exposed and uninsulated in a field in the countryside in one case.

The observed lesions were secondary to the coexistence of direct contact electrothermal burns and arcing burns in four patients. In the other cases, it was electrothermal burns.

In all patients, the point of entry of the current was on the hand, the exit point was at the level of the lower limbs in more than half of the cases (4 cases), in 3 cases the exit points were multiple (Figure 1).

These were intermediate burns with third degree burns at the entry and exit points of the stream. The extent of the burned area ranged from 5% to 50% of body surface area; in 4 cases, it was less than 20%, and in other cases more than 35%.

All patients benefited

- à biological assessment that showed an impairment of renal function secondary to Rhabdomyolysis in two patients with elevated muscle enzymes;
- an electrocardiogram: two patients had conduction disturbances.

A radiological assessment was performed in 2 patients looking for associated lesions caused by the fall due to the electrical accident and who returned without abnormalities.

After stabilization of the respiratory and hemodynamic state with adequate vascular filling to prevent myoglobinuric renal failure, preventive antibiotic therapy for community and anaerobic

organisms was initiated with routine tetanus serotherapy.

The syndrome of the lodges in the forearms was recorded in two patients (Figure 2) imposing early musculo-aponeurotic discharge incisions in emergency.

Upper limb amputations were performed in two patients (ie disarticulation of the shoulder in a patient) after systematization of the lesions (Figure 3).

Lower extremity amputations affected the toes in one patient. There was a rupture of the clean extensor tendons of the 2nd, 3rd and 4th fingers of the hand, on the contralateral side at the point of entry in a single patient, and which were repaired urgently (Figure 4).

One patient had high mid-cubital paralysis. Necrosectomies were performed in six of the seven patients, mainly at the entry points (Figure 5), taking necrotic tendons and nerves to the wrist exposing the noble structures in two patients imposing their coverage. The coverage of the different losses of substances was made by simple grafting of semi-thick skin after budding in most of our patients.

An expansion prosthesis was performed in a patient in the after-effects phase (Figure 6). Total skin grafts and release of the flanges were subsequently performed in two patients (Figure 7). There was a death in our series.



Fig-1 sorties multiples



Fig-2 Sd Volkman Avt bras



Fig-3 : Amputation avt bras et désarticulation épaule



Fig-4: Rupture tendineuse extenseur 2e, 3e, 4e doigts



Fig-5: Nécrose doigts



Fig-6: Refaite



Fig-7: refaite

DISCUSSION

The injuries caused by the passage of high voltage electrical current are serious and depend on the various parameters that characterize the contact with the conductor: current, voltage, resistance to current flow when it is continuous or alternating current impedance, frequency of the current, time and contact area.

When passing the electric current in a conductor, there is a release of heat that obeys the physical laws of Joule: $Q = I^2RT$ and Ohm: $I = V / R$.

In these equations, Q represents the heat release produced in joules, I is the current intensity in amperes, R the sum of the resistances in ohms, V the voltage in volts and T the contact time in seconds [2]. The lesions observed during the AEHV are thus of two kinds: some come from the depolarization induced by the passage of the electric current, the others from the heat which it releases in proportion to the resistance of the crossed tissues [3].

The voltage of the current is generally known during an electrical accident (AE). It determines the amount of heat released by the current according to the laws of Ohm and Joule [4]. High-voltage AEs, with current passing through the body, cause deep Joule-like burns along the vasculo-nerve axes between the entry and exit points, which are the site of deleterious lesions [5].

These lesions are progressive for three to four days after electrification, and preferentially follow tissues of lesser resistance (in order of increasing resistance: nerve < vessels < muscle < skin < tendons < fat < bone).

The most vulnerable elements are thus the neurovascular pedicles, the electrical current creating in particular intimal lesions responsible for extensive vascular thromboses. They can at the most create true ischemia of the affected limb and result in amputation;

these intimal lesions can sometimes go unnoticed (even with arteriography) [6].

The only truly reliable examination is the microscopic examination of the involved vessels: if free flap is indicated, the determining factor will be the microscopic appearance of the proximal end of the recipient vessel at the area to be treated [7].

In our series, the casualty population is an active population, very young and male. The negligence of parents and society first, the human error, the ignorance of the electric current, the imprudence are found in the electric accident. These were mainly accidents involving unsupervised and uneducated children about the risk of electrification as well as a lack of security at the level of electricity distributors and about a high-voltage exposed and uninsulated cable.

In contrast to thermal burns, the importance of deep skin lesions (second deep and third degree) contrasts with the extent of skin involvement that was less than 20% of body surface area in two-thirds of cases.

The general treatment includes the pre-hospital management at the accident site, and in a hospital environment allowing the stabilization of the respiratory state and the hemodynamic state, but also a surgical treatment resting initially in an emergency on the musculo-aponeurotic discharge incisions performed in one third of the cases in our series; but also on large necrosectomies to reduce the risk of superinfection and limit the general and functional consequences of rhabdomyolysis.

Due to the evolution of cellular lesions in the first days, excision of necrotic tissue is achieved after a delay of at least 72 hours after electrification [8]. In our series, the choice of timing and extent of resections was

based on careful inspection of lesions in dressings, so repeated necrosectomies were performed until complete removal of necrotic tissue. The amputations were made in the third of the cases in our series while having as objective to be conservative in order to allow a less incapacitating apparatus.

When a flap is needed, it is pediculated as far as possible from the "electrified" zone in order to be sufficiently distant from the vascular lesions; during extensive electrical burns, a remotely pedicled flap (inguinal flap, Colson's flap-graft [10], cross leg ...) is preferred to a flap taken from the same limb [9].

Likewise, semi-free flap coverage with micro-anastomosis on a donor site far removed from trauma to a conventional free flap with a potential recipient lesion [6] is preferred. In our series, the recovery of cutaneous losses of substance was carried out by dermo-epidermic grafts.

Once the lesions stabilized after a few months, nerve grafts and tendon transfers will be performed for the purpose of functional rehabilitation. The treatment is completed by functional rehabilitation sessions. The equipment completes the functional restoration.

In our series, sequelae were dominated by the disability of limb or limb loss related to amputations or joint stiffness; the other minor and aesthetic functional sequelae are represented by disabling and unsightly scars, mainly on the hands and trophic disorders in the lower limbs.

In all, surgery for high-voltage burns is often very bad and the functional consequences very heavy. Physiotherapy and early rehabilitation are particularly important in this context [11], as well as the management of psychological sequelae [12].

Efforts to prevent AEs are therefore essential [13]. It involves simple measures but also sometimes complex technical measures:

- posting of regulations on electrical safety, education of adults (parents) and children in particular;
- Vocational training and safety training in the workplace, particularly in occupations exposed to electrical current;
- require adequate facilities (sufficient number of plugs, limit the number of connections that lead to the wires dragging on the ground, prohibit "makeshift do-it-yourself" gathering many devices at the same source ...);
- adapt the equipment to work.

CONCLUSION

Electrical burns represent a medical and surgical emergency that must be known in all aspects in

order to consider appropriate and prompt orientation and therapy. Mortality related to electrical accidents has decreased significantly thanks to the development of pre-hospitalized medical care and thanks to advances in resuscitation. Unfortunately, the morbidity of accidents related to high voltage current is responsible for a functional invalid and remains major, so the cost of care for these patients remains particularly high, hence the importance of efforts to prevent.

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