Limb Gangrene Following High Tension Electrical Injury: The Need For Caution!

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Citation

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Abstract

BACKGROUND: High tension electrical injuries are uncommon in our society. They usually occur accidentally and often occupational. Resulting injuries which can be severe may lead to limb gangrene and subsequent amputation.
METHODS: Two cases of high tension electrical injuries which resulted in limb gangrene and eventual amputation are presented and prevention strategies highlighted. Case 1 was a 12 year old student who had gangrene of both feet and Case 2 was a 48 year old right handed electricity worker who sustained gangrene of his right hand following electrocution at work. Both patients were treated by limb amputation at various levels.
CONCLUSION: Gangrene treated by limb amputation may complicate high tension electrical injuries. There is need for caution to prevent this cause of loss of limb.

INTRODUCTION

Electrical injuries have become a more common form of trauma with a unique pathophysiology and with high morbidity and mortality. They consist of several types: lightning injury 1, high-voltage injury (>1000 volts), and low-voltage injury (< 1000 volts).2,3,4 High tension electrical injury is usually accidental. Generally, high voltage is associated with greater morbidity and mortality, although fatal injury can occur at household current (110 volts). Clinical manifestations range from transient unpleasant sensations without apparent injury to massive tissue damage. 5 Up to 40% of serious electrical injuries are fatal. 2,3,4 Electric current may be retained in the bones, causing heat and leading to necrosis and coagulation of small- to medium-sized vessels within the muscles and other tissues, almost completely sparing the skin. Blood vessels and muscles of the limb may also be affected leading to limb gangrene which is relatively uncommon6. Amputation is usually indicated in these cases. An epidemiological study of 383 cases in China underscores the need for stronger preventive measures.7

Appropriate knowledge of the mechanisms of injury and the principles of therapy improves patient care.8 It is essential to remember that the superficial appearance of an electrical burn may underestimate the degree of underlying tissue destruction. With electrical injuries the thought in regard to damaged extremities is to favour early and aggressive surgical management including early decompressive escharotomy, fasciotomy, carpal tunnel release or even amputation of an obviously nonviable extremity.9,10,11,12 In view of the limitation of function that usually results and the negative perception of amputation, it is imperative that all measures be instituted to prevent these injuries. Two cases of limb amputation following gangrene resulting from high tension electrical injury is reported to emphasize the need for caution as a preventive strategy.

CASE REPORTS

A 12 year old female, Primary School pupil, stepped on a high tension electrical wire that had cut and fallen to the ground the previous day following an episode of heavy rain storm. She was electrocuted and fell to the ground, sustaining extensive burns of both upper and lower limbs; and her trunk. Subsequently, she became unable to bear weight on both lower limbs. The toes of her right foot and the 1st and 2nd toes of her left foot later became dusky in colour and then frankly black.

She was taken to a nearby hospital where she was given initial treatment before referral to our centre. On presentation, she was in painful distress, pale, febrile, with extensive superficial and deep burns affecting her upper and lower limbs with black discolouration of the all toes of her right foot and 1st and 2nd toes of her left foot.

She was resuscitated, appropriate investigations done and wounds dressed daily. She had open right Lisfranc's amputation and ray amputation of left 1st and 2nd toes. Escharectomy and eventually split thickness skin grafting of the burns area was done with good outcome. The amputation stumps were closed and wounds healed satisfactorily.

CASE 2

A 48 year old male, right handed staff of the state electrical agency presented with black discolouration of the his right hand. He was working a high tension electrical cable without protective insulating hand devices when suddenly electrical current was introduced into the local network he was working on. He got electrocuted, fell from the height to the ground and sustained injuries to his right hand. A few days later, the right hand was noticed to have turned black with emission of foul smelling discharge. He also sustained an open injury on the dorsum of his right foot.

He was admitted, resuscitated and had right below elbow amputation. He declined skin grafting of the wound on his right foot. Amputation stump healed satisfactorily and he was subsequently discharged home. He is currently on alternate day dressing of the wound on his right foot.

FIGURE 1

Gangrenous right hand and distal forearm of patient II

FIGURE 2

Right Below Elbow amputation in Patient II

DISCUSSION

Electrical injuries can be life-threatening as cardiorespiratory arrest and major cardiac arrhythmias can occur 1. Approximately 20% of all electrical injuries occur in children, with a bimodal peak incidence highest in toddlers and adolescents. Most electrical injuries that occur in children are at home, with extension cords (60-70%) and wall outlets (10-15%) being by far the most common sources in this age group. 10 In adults, most electrical injuries happen at the workplace and constitute the fourth leading cause of work-related traumatic death. One third of all electrical traumas and most high-voltage injuries are job related. More than 50% of these occupational electrocutions result from power line contact (5-6% of all work-related deaths), and 25% result from using electrical tools or machines. The annual occupational death rate from electricity is 1 death per 100,000 workers, with a male-to-female ratio of 9:1.4

The 3 major mechanisms of electricity-induced injury are: electrical energy causing direct tissue damage, altering cell membrane resting potential, and eliciting muscle tetany; conversion of electrical energy into thermal energy, causing massive tissue destruction; and coagulative necrosis and mechanical injury with direct trauma resulting from falls or violent muscle contraction.

Factors that determine the degree of injury include the magnitude of energy delivered, resistance encountered, type of current, current pathway, and duration of contact. Systemic effects and tissue damage are directly proportional to the magnitude of current delivered to the victim.8,14,15 Tissues in the body have varying levels of susceptibility to electrical injuries - the least resistant being the nerves, blood vessels and the most resistant being the bone and fat. Nerves, designed to carry electrical signals, and muscle and blood vessels, because of their high electrolyte and water content, are good conductors. Bone, tendon, and fat have very high resistance and tend to heat up and coagulate rather than transmit current. Skin is the primary resistor to the flow of current into the body. Much of the energy may be dissipated at the skin surface, causing significant surface burns in a heavily calloused area, sometimes resulting in less deep internal damage than would be expected if the current were delivered undiminished to the deep tissues.16

High-voltage electrical injuries may be devastating, with extensive burns, amputations (as in our index patients), cardiac arrest and long complicated hospitalizations. The hand is the most common site of contact as it grasps a tool coming into contact with an electric source. Although all the muscles of the arm may be tetanically innervated by a shock, the flexors of the hand and forearm are much stronger than the extensors so that the hand grips the source of the current. At currents above the let-go threshold (6 to 9 mA), this can result in the person being unable to release the current source voluntarily thus prolonging the duration of exposure 16. Generally, the longer the duration of contact with high voltage current, the greater the degree of tissue destruction. This may explain the injury in the second patient.

The injuries sustained by these two patients which subsequently resulted in limb amputation were totally avoidable. Prompt removal of the fallen high tension wires by relevant authorities would have prevented the extensive injuries sustained by the first case presented. There is need to educate the populace on the benefit of being more watchful and sensitive to strange and unusual devices in their environment and avoiding contact with them.

The use of protective hand insulation devices is essential while working on any electrical cables. This usually confers some protection should there be an accidental contact with live electrical cable. Similarly, appropriate coordination between the field staff and power control substations to ensure that high tension cables being worked on are completely devoid of electricity until conclusion of any such work by staff. In the second patient, it appears the high tension cable was powered before conclusion of the maintenance work by the patient without prior warning. This was a completely avoidable accident!

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