# Two Cases of an Unusual Presentation of Electrical Burn Injuries

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## ABSTRACT

**Electric injuries have a wide variety of consequences ranging from disfigurements, extremity loss, and death. The limbs are the most affected sites because of the high resistance of muscles and tendons to electricity. The most common pathway of entry to exit point is upper limb to lower limb, so the thigh to foot pathway is exceptional. In this case report, we aimed to present the mechanisms in 2 construction workers who had high-voltage electric burns that followed this unusual pathway.**

**KEY WORDS:** *Entry and exit wound, High-voltage burn, Occupational injury*

## INTRODUCTION

Electrical injuries are potentially devastating and represent less than 5% of admissions to burn units in developed countries but up to 27% in developing countries. Electrical injuries are a life-threatening problem in Turkey because of lack of awareness regarding safety issues among the general public.[1-4] These injuries are more frequent in young adult men because of occupational exposure and include primarily electricians over 15 years of age and students under 15 years of age.[5] The electrical injury is unique because the outward appearance does not accurately predict the true extent of the injury; electrical exposure may cause a flash and external burn but also internal burns from the current.[4,6] Although the magnitude of the injury is related to several factors such as the current, voltage, resistance, duration, and pathway, the voltage is the main determinant of the degree of tissue damage. The electrical injuries are divided into high voltage (>1000 V), low voltage (<1000 V), and electrical flash burns.[6] The most significant sign of the passage of electricity is the electric burn mark[7-9]; however, in cases of severe burns, especially from high-voltage currents, the marks may not be evident due to the extensive lesions. It is important to also keep in mind that in some cases of high-voltage accidents the electric shock may result in the individual falling from a height, thus generating a secondary blunt trauma. Entry marks are usually seen in the hands, with exits often in moist skin areas such as the axilla, groin, or the sole of the foot. The marks can also be present in uncommon sites, such as the head, face, mouth, lips, eye, and external genitalia.[10-16] Here, we report 2 cases of unusual accidental electrical burns where the entry and exit points were located in the same extremity.

## CASE REPORT

### Case 1

A 29-year-old male construction worker, with no relevant past history, experienced a work-related accident. He was shocked by an electric current while working on a public road in the morning. The task involved guiding and unloading by hand a steel plate lifted by a truck-mounted crane parked near overhead high-voltage power lines. During the procedure, the crane accidentally contacted a 6300-V overhead energized line, with the patient providing a path to ground and being electrocuted with the consequent electrical injuries (Figure 1). There were no reports of associated trauma. He was admitted to our burn unit for monitoring and surveillance. On admission to the burn unit, the patient was oriented, conscious, and breathing spontaneously. He was wearing safety boots with steel toes.

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He denied shortness of breath, nausea, thoracic pain, and/or palpitations. The following vital signs were recorded: body temperature of 36.3 °C, pulse of 94 beats/min, respiratory rate of 23 breaths/min, blood pressure of 125/73 mm Hg, and a room air-blood oxygen saturation level by pulse oximetry of 89%.

A physical examination identified the following third-degree electrical burn-related eschar formations: 3% on the anterior aspect of the left thigh, 1% on the lateral aspect of the left foot, 1.5% of the dorsal aspect of the right foot, and punctate lesions observed in the volar and second fingertip of the left hand. The burns included 5.5% of his total body surface area. Signs of electrical conduction input were on the left anterior thigh, and the output was identified on both feet (Figure 2). No other electrical wound was found in the rest of the body after thoroughly looking for any other possible wounds or marks. Bilateral lower extremity Doppler ultrasonography results were unremarkable. Escharotomies were performed after fluid resuscitation under general anesthesia in the burn unit within the first 24 hours of hospitalization.

An electrocardiogram revealed normal sinus rhythm with a heart rate within the normal range. Blood tests performed on admission revealed hypermyoglobinemia >12 000 ng/mL, a very elevated creatine phosphokinase level of 39 477 U/L with a creatine kinase-myocardial band level of 259.6 U/L, and a high-sensitive troponin I level within the normal range. Aspartate aminotransferase (508 U/L), alanine aminotransferase (111 U/L), and lactate dehydrogenase (1515 U/L) levels were high, and

**FIGURE 1.** Illustration of the Injury

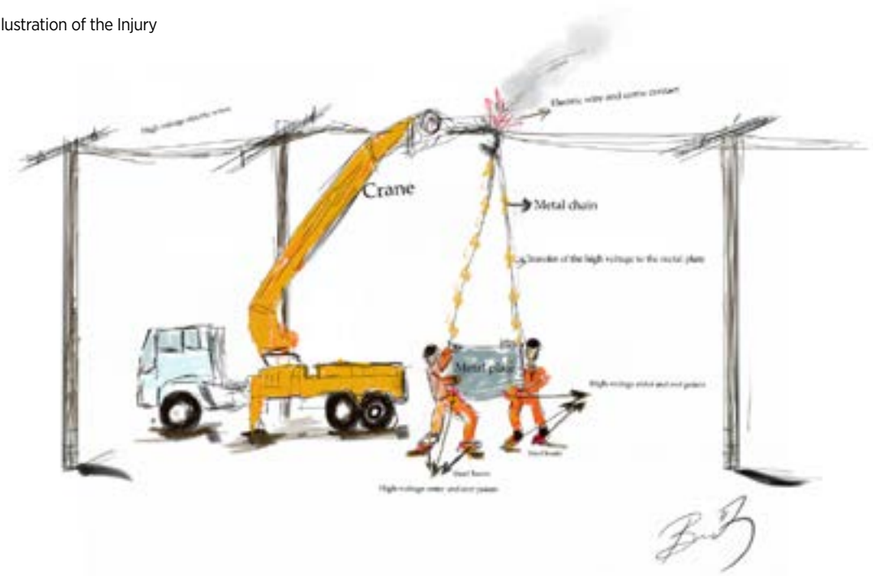


**FIGURE 2.** Entrance and Exit Points of Case 1



**FIGURE 3.** Reconstruction of Injury Zones in Case 1

estimated glomerular filtration rate was normal. The urine test revealed microscopic hematuria. Follow-up laboratory tests showed improvements, with alanine aminotransferase progressively increasing and reaching its peak by day 9 after admission before starting to slowly decrease. Creatine phosphokinase level went from 39 477 to 1007 U/L by day 9 after admission, and the aspartate aminotransferase and lactate dehydrogenase levels trended down starting at day 1 to reach normal levels after day 10.

The patient was given aggressive fluid resuscitation, and vital signs and urine output were monitored. Daily wound care was performed with silver sulfadiazine. Two debridement procedures were performed within 1 week. Nine days after admission, the patient received surgery to close the open wounds of 9 × 5 cm on the left thigh, 6 × 3 cm on the left foot, and 5 × 4 cm on the dorsum of the right foot with a split thickness meshed skin graft at ratio of 2:1. The donor site was the anterolateral aspect of the right thigh (Figure 3).

## Case 2

A 22-year-old male construction worker (coworker of the case 1 patient), with no relevant medical history, experienced the same work-related accident after being in direct contact with the steel plate lifted by the crane (Figure 1). He was also admitted to our burn unit for monitoring and surveillance due to the electrical injuries. His physical examination revealed second- and third-degree burns affecting 4.5% of the total body surface area. Full thickness burns were noted on the right thigh, representing the point of entry of the electric current (Figure 4). The right foot was the presumed point of exit as evidenced by the presence of third-degree burns. During the examination, the patient was oriented, conscious, and breathing spontaneously. He denied shortness of breath, nausea, chest pain, and/or palpitations. Vital signs recorded were within normal limits.

**FIGURE 4.** Electric Burn Exit Point in Case 2

An electrocardiogram on admission also showed normal results. A bilateral Doppler ultrasonogram revealed no evidence of vascular injury. Immediate escharotomy was performed on bedside after starting aggressive fluid resuscitation.Within the first 72 hours after admission, the patient underwent wound debridement in the right thigh and the dorsum of both feet. Amputation of the fifth toe was performed because of severe necrosis directly related to the electrical injury. The defect on the right foot was reconstructed with thoracodorsal artery perforator flap (Figure 5).

**FIGURE 5.** Reconstruction of Right Foot Dorsum With Free Thoracodorsal Artery Perforator Flap in Case 2

## DISCUSSION

Electric burns are one of the life-threatening traumas. It generates a wide variety of clinical consequences. The damage is generated by the passage of electrons through the tissues, so that the body becomes incorporated into an electrical circuit.[7,17] The current will preferentially flow through the tissue of greatest resistance, and the skin is the tissue with the most amount of resistance in the human body, followed by bone. Nerves, muscle, and blood have the least amount of resistance.[17] The severity of the injury is inversely proportional to the cross-sectional area of the body part, with the most severe regions of injury seen in the wrist and ankle and decreasing proximally. Vascular injuries can also occur, and these injuries can be irreversible.[18] Although the magnitude of the injury is related to several factors, such as current, voltage, resistance, duration, and pathway, the voltage is the main determinant of the degree of tissue damage.[6]

There are unusual entry and exit points reported in the literature, such as head, face, mouth, lips, eye, and external genitalia.[10-16] Although extremities have been reported to be the sites that are most affected,[19] our 2 cases are notable because of the presence of third-degree burns at unusual entry-to-exit point pathways without severe upper extremity involvement.

Both of the patients reported here had injuries after contact of a crane with electric wires, resulting in a high-voltage energy circuit. In this circuit, the victims provided a path to ground while the metal plate entered in contact with their anterior thigh. The contact points displayed third-degree burns, and the exit points were aggressively damaged. Hypothetically, the lesions in the anterior aspect of the thighs were aggravated due to the heaviness of the object they were carryıng, which induced a prolonged contact and exposure to the heat generated by high resistance. Another potential aggravator was the fact that the patients were wearing steel toe safety boots, which generated a flash burn in the foot, damaging the surrounded skin without involving deep tissues.

An 11-year survey of electrical burn injuries conducted in 1995 reported the misuse of electrical appliances, inattentiveness, lack of education in safety precautions, and lack of parental supervision as main causes of electrical burns in Turkey.[20,21] On average, 15 electrocutions were reported as caused by contact between cranes touching overhead power lines, and over 50% of these crane-related accidents occurred in the construction industry.[22]

## CONCLUSIONS

Electrical burns are uncommon; however, patients with these injuries require special attention. Problems associated with these injuries can be very high for both the patient and the health care team despite great advances in treatment options. Patients with electrical burns often have severe physical and psychological consequences. A pathway limited to the same extremity is not usual; in addition, wearing inappropriate personal protective equipment can aggravate the severity of the lesions. The 2 cases present here remind us of the importance of following safety procedures for construction workers; staying in accordance with the guidelines can reduce the incidence and severity of the injuries.

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