

# Electrical Burn with Abdominal Visceral Involvement Managed by Immediate Aggressive Debridement and Flap Coverage

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**E**lectrical burns can present in several forms. The first is flash burns, where a cloud of hot gases generated by the evaporation of electrical wires and their insulations heat the skin. As the thermal capacity of these gases is relatively low the damage is usually limited to the skin surface. The second form is electrocution, which is tissue necrosis caused by electrical current passing through tissues that results in coagulation of the surrounding tissue by direct electrical energy as well as by heat generated by tissue resistance to current flow. Electrical arc injuries, a third form of electrical burn presentations, tend to be severe and can cause skin burns by direct heat exposure or by igniting clothes. It produces intense heat, and fatal lesions can occur even when the victim is several feet from the arc.

Electrical current is responsible for 2–20% of burns admitted to burn units [1,2]. These injuries are more common in developing than in developed countries. In cases of domestic accidents the voltage is generally low (up to 220 V) and the damage is usually limited, but in cases of high voltage injuries the morbidity and mortality rates are high. Electrical burn injuries are often deceptive, because unlike other burns there is no correlation between the

extent of damage seen on the surface and the severity and extent of the deep damage in the patient's organs. The extent of the tissue damage involves not only anatomic structures but also vital physiological systems deranging the patient's homeostasis, sometimes irreversibly [3,4]. The upper and lower limbs are involved more frequently than the head, neck and torso regions [5]. Visceral organ involvement is extremely rare but carries a very high morbidity and mortality rate [1]. We present a patient injured by a high voltage electrocution injury with visceral involvement who survived and recovered in a short time due to immediate surgical debridement followed by flap and skin graft reconstruction.

## PATIENT DESCRIPTION

A 47 year old electrician was wiring a high voltage transformer when his colleague

mistakenly turned the main current switch on. The technician was trapped on a pole six meters above the ground, squeezed between the transformer's ribbed metal block and the metal pole. It took the fire department approximately 30 minutes to safely get him to ground and 10 more minutes for paramedics to bring him to the hospital. In the emergency room the patient was fully conscious. The cardiac rhythm was sinus 120 per minute, blood pressure 100/60 mmHg, and respiratory rate 16 per minute.

Full-body examination revealed a deep charred wound measuring 10 x 15 cm on his right upper abdominal quadrant, surrounded by more superficial third and second-degree burns [Figure A], a scalp burn of 3 x 10 cm involving all layers of the scalp, a left upper back burn of 5 x 25 cm showing exposed muscles, and third-degree burns on his left pretibial region and right arm.



**[A]** Patient's abdominal wound on admission



**[B]** Abdominal CT scan on admission showing subcapsular liver hematoma (black arrow) and pneumoperitoneum (white arrow)

The total body surface area burned was 25%. Laboratory tests on admission showed leukocytosis, elevated liver function tests, lactate dehydrogenase, creatine phosphate kinase, amylase, and myoglobin. Computed tomography showed a subcapsular liver hematoma and pneumoperitoneum, with no evidence of free intraperitoneal fluid [Figure B].

The patient was taken immediately to the operating room where he underwent extensive surgical debridement of necrotic tissues and reconstruction. The entire thickness of the right upper abdominal and lower chest walls including the lower three ribs were debrided, leaving the pleura intact. The exposed liver showed signs of electrical damage, but hepatic resection was not performed. Peritoneal exploration did not show any hollow viscera perforation. The chest and abdominal walls were reconstructed with a polyglycolic acid mesh covered by a contralateral superiorly based rectus abdominis muscle flap covered by a split-thickness skin graft. The scalp wound was debrided and reconstructed with a transposition scalp flap and a split-thickness skin graft to the donor site. Necrotic muscles and skin were debrided from the back and the defect was covered with a split-thickness skin graft. A left leg anterior compartment fasciotomy was performed and the left leg and right arm were treated with

tangential excision of burn eschar and a split-thickness skin graft.

Five days after the accident the patient was transferred from the intensive care unit to our ward after being weaned from hemodynamic and respiratory support. His condition improved and a gradual normalization of laboratory results was seen. During weeks 6 to 10 post-injury the patient was taken five times to the operating room for minor debridement and skin-grafting procedures. He was discharged after 51 days and continued his physical therapy and burn scar follow-up in our outpatient clinic [Figure C]. Six months after the injury the patient required release of an axillary contracture and skin grafting. He returned to work several months later.

**COMMENT**

Electrocution is a devastating trauma with tissue damage that may propagate far from the point of electrical contact, and secondary complications that may be lethal. Treatment strategies differ between the more conservative, serial, limited debridement procedures that follow the progression of tissue death and the more aggressive ones where a thorough debridement is attempted soon after admission.

The patient reported here was caught high above ground between a high volt-



**[C]** Patient's chest and abdominal wound scars 3 months after injury

age transformer and an iron pole and sustained a severe high voltage electrical injury. Fortunately, he did not die immediately due to arrhythmia and survived the duration of his rescue. After the patient's initial resuscitation a CT scan was performed to seek other injuries that may have been caused by mechanical trauma. Subcapsular hepatic hematoma and pneumoperitoneum were demonstrated. The differential diagnosis of pneumoperitoneum was perforation of a hollow viscera, pneumothorax, or external air penetration. Pneumothorax was ruled out by physical examination and a chest radiograph.

In view of the deceptive nature of electrical injury, we decided on an aggressive approach, namely, exploring potential gut perforation along with extensive debridement of devitalized tissue and immediate reconstruction. The immediate removal of large masses of necrotic tissues – which included skin, subcutaneous tissues, muscle and bone – prevented local and

systemic viscous effects of these tissues such as secondary renal damage. Stopping the formidable flow of toxic products into the bloodstream combined with the immediate reconstruction and protection of the large raw defects is reflected in the rapid normalization of laboratory values and the patient's speedy recovery.

In summary, we believe this approach may have made the difference between a slow recovery with potential septic haz-

ards and the relatively fast recovery that occurred in our patient.

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### Capsule

#### Obesity-induced gut microbial metabolite promotes liver cancer through senescence secretome

Obesity has become more prevalent in most developed countries over the past few decades, and is increasingly recognized as a major risk factor for several common types of cancer. As the worldwide obesity epidemic has shown no signs of abating, better understanding of the mechanisms underlying obesity-associated cancer is urgently needed. Although several events were proposed to be involved in obesity-associated cancer, the exact molecular mechanisms that integrate these events have remained largely unclear. Yoshimoto and co-researchers show that senescence-associated secretory phenotype (SASP) plays a crucial role in promoting obesity-associated hepatocellular carcinoma (HCC) development in mice. Dietary or genetic obesity induces alterations of gut microbiota, thereby increasing the levels of deoxycholic acid (DCA), a gut bacterial metabolite known to cause DNA damage. The enterohepatic circulation of DCA provokes SASP phenotype in hepatic stellate cells

(HSCs), which in turn secrete various inflammatory and tumor-promoting factors in the liver, thus facilitating HCC development in mice after exposure to chemical carcinogen. Notably, blocking DCA production or reducing gut bacteria efficiently prevents HCC development in obese mice. Similar results were also observed in mice lacking an SASP inducer or depleted of senescent HSCs, indicating that the DCA-SASP axis in HSCs has key roles in obesity-associated HCC development. Moreover, signs of SASP were also observed in the HSCs in the area of HCC arising in patients with non-alcoholic steatohepatitis, indicating that a similar pathway may contribute to at least certain aspects of obesity-associated HCC development in humans as well. These findings provide valuable new insights into the development of obesity-associated cancer and open up new possibilities for its control.

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### Capsule

#### USA tries to tighten exemptions from mandatory vaccinations

In the United States, states have the authority to grant exemptions so that children can begin to attend school without having been vaccinated against childhood diseases. Medical exemptions can be granted when a child has a history of allergic reactions or is immunocompromised. However, there has been a noticeable increase in the numbers of unvaccinated children resulting from non-medical exemptions, based on religious or philosophical grounds; in 2011–2012, roughly 80% of all exemptions were non-medical. Blank et al. have gathered information from public health officials, health departments, the Centers for Disease Control and Prevention, the National Conference of State Legislatures, and state legislature databases. Policies were characterized as easy, medium, or difficult, according

to the level of effort they would pose for parents requesting exemptions. The lower the barrier, the more non-medical exemptions were observed, with a twofold difference between the easiest and most difficult procedures. For 2011–2012, at least 21 bills were introduced at the state level to change the exemption procedures, and exemptions would have been made easier if bills in 10 states had passed. As of February 2013, three bills have been introduced in two states to tighten exemptions, and five bills have been introduced in four states to loosen them. The authors advocate social and policy efforts to promote parental education and to stem the spread of vaccine-preventable diseases.

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