A CASE REPORT OF TRAUMA: HEAD INJURY SUSTAINED FROM A FALL FOLLOWING HIGH-VOLTAGE ELECTROCUTION

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ABSTRACT

Electrical injuries are a frequent type of physical trauma and are frequently linked with significant rates of morbidity and mortality. Without prompt treatment, electric injuries can lead to fatal harm, causing dysfunction in multiple organs or tissues. A 36-year-old male was brought to the emergency department with multiple injury due to falling from the roof after being electrocuted by high-voltage. The patient was diagnosed with brain hemorrhage, multiple fracture to the head, and burn injury to his upper and lower extremity. Surgical intervention was performed to evacuate the hemorrhage and the fractured frontal bone. Debridement was also performed by the general surgeon to treat the burn injury. The patient was then transferred to the ICU. Electrical injuries, which often result in substantial morbidity and mortality rates, require prompt treatment due to their potential to cause fatal harm and dysfunction in multiple organs, particularly the nervous system, emphasizing the importance of awareness and proper management to save lives.

Keywords: Head Trauma; Brain Injury; Intracranial Hemorrhage; Fall; Electrical Burn

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INTRODUCTION

Electrical injuries are a frequent type of physical trauma and are frequently linked with significant rates of morbidity and mortality (Zemaitis et a., 2023). Electrical traumas are common, occurring frequently in both workplace and household settings, often involving electronic devices. In Indonesia, data on electric injuries remains scarce; however, an epidemiological investigation of electric injury patients at the Burns Unit of Cipto Mangunkusumo Hospital during 2009 – 2010 revealed that 11.8% of the treated individuals had suffered from electric injuries (Suzan and Andayani, 2017).

The prevalence and incidence of head injuries due to electrical trauma is unknown. However, electrical trauma can cause indirect head injuries, one of which is due to falls (Gentges and Schieche, 2018). Falls are the second most common cause of traumatic brain injuries (TBIs), contributing to 20-30% of all cases. In the United States, almost 17,500 deaths from fall-related traumatic brain injuries occurred in 2017 (Peterson and Kegler, 2020).

Individuals who survive electrical injuries may encounter complications, whether immediate or delayed. Without prompt treatment, electric injuries can lead to fatal harm, causing dysfunction in multiple organs or tissues. Conditions affecting various organs such as the heart, blood vessels, and internal organs are common, with cerebral injuries, spinal cord lesions, peripheral nerve injuries, and motor and autonomic neuropathy being the most prevalent neurological disorders (Roshanzamir et al., 2014).

In this case report, we describe a patient who suffered a head injury due to a fall following a high-voltage electrocution.

CASE

A male Mr. Y, 36 years old, was brought to the emergency department with multiple injury to the body after fall from 3 cm concrete 1 hour before admission. The patient was exposed to an electric shock when he accidentally touched a high voltage wire with both of his hands while working on the roof of a house. The patient was unconscious for 30 minutes. Upon regaining consciousness, the patient experienced vomiting without projectile expulsion. Throughout the journey to the hospital, the patient exhibited signs of drowsiness.

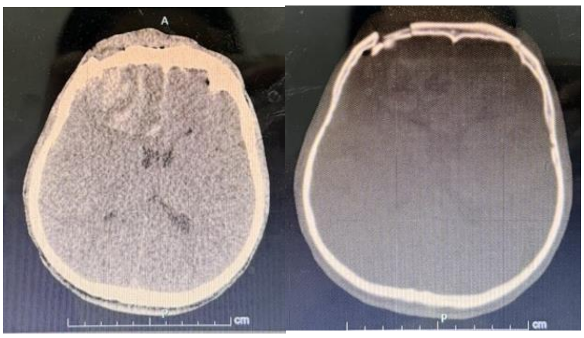
Upon initial examination, he came with a GCS score of 13 and presented with extensive full-thickness burns on both palms, along with multiple superficial partial-thickness wounds on his wrists, right leg (Figure 1A), and both fee (Figure 1B), totaling approximately 25% of his body surface area affected. The electrical burns' entry points were identified on his palms (Figure 1A), with exit points observed at his toes (Figure 1B). The patient also presented with a depressed frontal and wound to his forehead and chin (Figure 2). The patient vital signs showed BP 113/67, HR 94, RR 22, T 37. Normal capillary refill time was noted at the fingertips, although was decreased sensation to touch and pressure. Immediate wound care involved the application of liquid silver sulfadiazine cream. Blood tests indicated leukocytosis and elevated liver enzymes. An electrocardiogram showed a normal sinus rhythm, ruling out cardiac damage.

Figure 1. Entry zone on both hand, second degree burn on right upper leg (A, above,,,,,,,,`); and Exit zone (B, below).

Figure 2. Depressed frontal with wound over his forehead and chin.

Imaging findings showed intraparenchymal hemorrage with perifocal edema and pneumocephalus in right frontal lobe, subarachnoid hemorrhage and facture of the frontal bone (Figure 3). It also showed fracture of the frontal sinus, both side of the maxillary, lateral wall of the orbital, right ethmoid bone, nasal septum, nasal bone with cephalohematoma and subcutaneous emphysema, and hematoma paranasal sinus. In the emergency department, the patient received fluid resuscitation of 1500 mL ringer lactate, catheterized with 16F foley catheter, and initial mannitol dose of 250 mL followed by a maintenance dose of 4x125 mL.

After initial treatment, a surgical intervention was scheduled both for the head injury and the burn injury. The hemorrhage was evacuated through craniotomy. During the surgery, it was found that the frontal love was burst. Debridement was also performed by the general surgeon to treat the burn injury on his upper and lower extremity. The wound was meticulously cleaned by washing it with saline solution. The wound care treated with every day debridement of changing wet gauze and applied silver sulfadiazine cream (Silvadene, thermazine, flamazine, SSD), a 1% water-soluble cream, is a combination of sulfadiazine and silver. After the surgery, the patient was transferred to the ICU as he was still needing ventilator. The patient was again given mannitol for two more days. On the second day after the surgery, the patient regained consciousness and recovered well. He was discharged a week after.



(A) (B)

Figure 2. CT-scan shows intraparenchymal hemorrhage with perifocal edema and pneumocephalus in right frontal lobe and subarachnoid hemorrhage (A); CT-scan shows fracture of the frontal bone (B).

DISCUSSION

Electric injuries may arise from lightning strikes, low-voltages, or high-voltage accidents. Electric injury happens when an individual encounters the current generated by a source, which can be either artificial or natural (Zemaitis et al., 2023).

Electric injuries typically result from three primary mechanisms: direct tissue damage and alteration of resting membrane cell potential caused by electrical energy, leading to muscle tetany; transformation of electrical energy into heat energy, resulting in extensive tissue damage and coagulative necrosis; and direct trauma from falls or intense muscle contractions, causing mechanical injury (Elfiah and Suryani, 2019). Physical injuries can happen in instances of both low-voltage and high-voltage electric shocks, as patients might instinctively recoil from the shock, leading to potential loss of balance and subsequent falls, resulting in further trauma, and other forms of blunt trauma (Gentges and Schieche, 2018). This occurred to the patient who, following electrocution by a high-tension wire on his roof, fell and sustained a fracture to his frontal bone and other facial bones.

Electrical trauma with high voltage or lightning strikes can cause secondary complications in the form of spinal, peripheral nerve and cerebral injuries, which can occur immediately or later, appearing from the first day to several months. The injuries that occur are not limited to the location of the nerves whose tissue is in direct contact with the electrical source (Arisetijono et al., 2020). In cases of electrical trauma, traumatic brain injury can arise as a direct or indirect consequence. This could result from the current passing through the body, the patient being thrown off balance post-electrocution and suffering head trauma, or a combination of both scenarios. The injury might manifest as a closed or penetrating head injury, typically necessitating prompt surgical intervention (Narang et al., 2023).

Head trauma encompasses a diverse array of injuries affecting the scalp, skull, brain, as well as the underlying tissues and blood vessels. Major contributors to head injuries include incidents involving falls (Ghandour et al., 2022). Evaluation of head injuries can be conducted using the Glasgow Coma Scale, considering clinical conditions (Kemenkes RI, 2022). Head injuries are categorized into three groups depending on the Glasgow Coma Scale (GCS) score:a GCS score of 13-15 indicates a mild head injury, a score of 9-12 indicates a moderate head injury, and a score of 8 or lower indicates a severe head injury.

Besides GCS score, moderate head injury can be diagnosed by clinical symptoms which include loss of consciousness lasting from over 10 minutes to 6 hours, presence of neurological deficits, and abnormalities detected in a head CT-scan, excluding intracranial bleeding. A post-treatment diagnosis may also be considered of hospital treatment extends beyond 48 hours (Perdossi, 2006). This aligns with the patient's situation, which included a period of unconsciousness lasting 30 minutes, an abnormal CT-scan excluding intracranial bleeding, and a hospitalization exceeding 48 hours, thus indicates a moderate head injury in the patient.

Apart from abnormalities in the nervous system, electrical trauma can also affect the cardiac system which can have fatal consequences. Heart abnormalities following electrical trauma can stem from various mechanisms. These include coronary artery spasms, direct thrombogenic effects on coronary arteries, thermal impacts on myocardial tissue, secondary ischemia due to arrhythmias inducing hypotension, ischemia in coronary arteries due to broader vascular injury, and myocardial injury from halted breathing. Cardia arrests, often occurring as asystole or ventricular fibrillation, are common. Additional electrocardiogram (ECG) manifestations encompass sinus tachycardia, transient ST segment elevation, reversible QT segment prolongation, premature ventricular contractions, atrial fibrillations, and bundle branch blocks (Arisetijono et al., 2020). Upon the patient's initial hospital arrival, EKG was immediately performed on him, and the results shows normal sinus rhythm. Apart from that, laboratory tests also show no abnormalities that indicate cardia damage; thus, it can be ruled out.

The care of every burn patient, whether caused by electricity or not, begins as soon as the patient arrives in the emergency room. During the initial assessment, all potential injuries, both immediate and delayed, must be considered. After administering initial emergency care (addressing airway, breathing and circulation), the patient should undergo fluid resuscitation (Narang et al., 2023). As for the head injury, a through neurological assessment and evaluation are necessary to determine the necessity of surgery. Open head injuries require immediate management, considering the high risk of infection. It's crucial never to neglect spinal immobilization (Yiannopoulou et al., 2021).

Following completion of the primary and secondary surveys, the patient received fluid resuscitation of 1500 mL with Ringer Lactate according to the Parkland Formula and initial treatment with mannitol before undergoing surgical intervention to remove the hemorrhage and fractured frontal bone. The patient was also catheterized to monitor his urine output. Unfortunately, in this case patient did not receive spinal immobilization with a cervical collar and did not undergo a spina imaging to rule out spinal injury as per the ATLS algorithm (John, 2015).

Every critically ill patient needs fluid administration throughout their illness, and this applies equally to neurocritical patients. In neurocritical patients, fluid therapy aims to enhance cerebral perfusion while simultaneously reducing the risk of additional or secondary brain damage. Research has extensively highlighted the negative impacts of both hypovolemia and hypovolemia in neurocritical patients. Given the repeated emphasis on the risks associated with both under- and over-resuscitation, it is crucial to closely monitor fluid management. Monitoring fluid resuscitation in neurocritical patients should encompass a range of parameters using multiple modalities, such as monitoring the urine output with a target of 0.5 mL/kg to 1 mL/kg for adults (Kishen, 2024). In this instance, there was no documentation of urine output in the medical records, preventing us from evaluating the effectiveness of fluid resuscitation in the patient.

The general surgeon also conducted debridement on the patient. After a thorough debridement with saline solution, the wound was treated with silver sulfadiazine cream (also known as SSD, thermazine, flamazine, or Silvadene), a 1% weter-soluble cream that combines silver and sulfadiazine. By binding to the organism's DNA, the silver ion releases sulfonamide, which disrupts the microbe's intermediate metabolic pathway. It works best against *S. aureus* and *P. aeruginosa*. Both closed and open approaches can be used to apply silver sulfadiazine with comparable effectiveness. A medication called silver sulfadiazine is used to treat, prevent, and manage infections in burn injuries. This topical medication has antibacterial qualities and contains a heavy metal (Gallagher et al., 2912; Oaks and Cindass, 2024).

The patient was then transferred to the ICU after where he regained consciousness two days after the surgery. He was given mannitol for a total of two days in the ICU before he finally was moved to the regular ward. Mannitol has been used in clinical settings for an extended period as an osmotic agent to promptly for a duration not exceeding 5 days to mitigate the risk of adverse effects like fluid and electrolyte disturbances, pulmonary edema and renal failure (Guo et al., 2015).

CONCLUSION

Electrical injuries are a frequent type of physical trauma and are frequently linked with significant rates morbidity and mortality. Without prompt treatment, electric injuries can lead to fatal harm, causing dysfunction in multiple organs, such as the nervous system, or tissues. Electrical injury may have direct or indirect effects on the nervous system; therefore, awareness of this issue and appropriate approach are essential to save patients' lives.

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