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A CASE REPORT: REVEALING DELAYED CARDIAC PHENOMENON IN ELECTRICAL BURNS, AN INTERESTING PUZZLE

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ABSTRACT

Introduction: Electricity is an integral aspect of modern life but poses potential long-lasting consequences. Electrical burns, although infrequent, hold significant implications and can lead to adverse cardiac outcomes. This study explores the intricate interplay between electrical injuries, neurological responses, and cardiac manifestations, emphasizing the need for comprehensive understanding and management.

Case Illustration: A 28-year-old male tile builder sustained an electrical shock while working on a rooftop. He experienced convulsions and unconsciousness after his hair entangled with a high-voltage cable. Clinical evaluation revealed burns and vital signs within the normal range. Subsequent electrocardiogram (ECG) assessments unveiled ST-segment elevation and hyperacute T waves. Troponin I levels increased on the third day, indicative of a myocardial infarction (MI) induced by the electrical injury.

Discussion: Electrical burns are complex and necessitate a multidisciplinary approach for accurate diagnosis and management. Collaborative efforts involving burn surgeons, cardiologists, and neurologists are essential to comprehend the holistic impact of electric injuries. This case shows that electrical injuries leading to loss of consciousness can later result in heart issues, as evidenced by significant electrocardiogram changes, emphasizing the need for ongoing monitoring. It underscores the importance of an interdisciplinary approach in managing burn injuries, particularly electrical burns, which can have hidden complications.

Conclusion: Understanding the intricate dynamics between electrical injuries, neurological responses, and cardiac outcomes can improve therapeutic strategies and patient outcomes. This case underscores the importance of thorough and all-encompassing management to ensure the best possible care for the patient.

Highlights:

1. Electrical injuries pose risks to the heart, with differing outcomes based on voltage exposure.
2. The importance of ongoing observation is due to the development of delayed cardiac issues.
3. Collaboration among medical specialties is essential to manage electrical burn injuries and associated cardiac complications effectively.

INTRODUCTION

Electricity stands as an indispensable cornerstone of contemporary human existence, yet it retains the capacity to yield enduring repercussions. Although modern life relies heavily on electricity, it remains consequential, bearing the potential to impose lasting adversities. Among these, electrical burns emerge as

prominent consequences, capable of transpiring within both domestic and occupational milieus. While comparatively uncommon, the impact of electrical injuries on cardiac health assumes paramount significance due to their potential for gravely adverse outcomes.[1]

Traditionally, the classification of electrical injuries segregates them into distinct categories high-voltage exposures, exceeding the threshold of 1000 V, and low-voltage exposures, confined below this demarcation. Significantly, the heart is predisposed to heightened vulnerability in such scenarios.[1] Specifically, low-voltage electrical injuries tend to precipitate ventricular fibrillation a state of tumultuous cardiac rhythm while instances of high-voltage exposure more frequently culminate in asystole, marking a comprehensive halt in the heart's electrical activity.[2]

Sometimes, electrical exposure can cause a rare but major complication: myocardial infarction (MI), a condition characterized by impaired blood perfusion to the heart muscle. These symptoms usually appear immediately after electrical injury, but several cases show delayed heart defects.[2] Research into complications of burns to the heart, especially late myocardial infarction, is still ongoing. Several hypotheses have been put forward by experts regarding the pathogenesis and management, but they are still being debated.[3]

This particular case study describes an example in which an electrocardiogram showed marked ST-segment elevation an indicator of myocardial tension while Troponin I levels showed a marked increase on the third day of therapeutic management.

CASE ILLUSTRATION

We present a compelling case involving a 28-year-old male patient who arrived at the emergency room following a fall from a height after an electrical shock incident. The patient, employed as a tile builder, was engaged in the repair of roof tiles while positioned in a seated stance. A lamentable mishap transpired when the patient's hair became ensnared in a high-voltage cable (> 1000 Volts), provoking immediate convulsions and ensuing loss of consciousness. This sequence of events culminated in the patient's descent from the rooftop, which measured approximately 2 meters. Upon his admission to the hospital's emergency department, the patient had successfully regained consciousness. The patient communicated experiencing a headache and weakness; however, notable absences were complaints of nausea, vomiting, or chest pain. Pertinently, the patient's medical history bore no evidence of chronic ailments or antecedent cardiac afflictions.

A comprehensive physical assessment unveiled the patient had full consciousness, as ascertained through a Glasgow Coma Scale score of 15. Recorded vital signs encompassed a blood pressure reading of 133/85 mmHg, a pulse rate of 71 beats per minute, and a respiratory rate of 20 breaths per minute. Anthropometric data of the patient showed a body weight of 65 kg, a height of 165 cm, and a calculated body mass index (BMI) of 23.8 kg/m^2. The Wong-Baker face pain scale quantifying pain intensity resulted in a score of 3.

Figure 1. Clinical Manifestation

Further physical examination illuminated disruptions in the patient's integumentary tissue, exhibiting a spectrum of hues from pale pink to bright pink and white, which signified varying levels of injury to the dermal and subdermal layers. Calculation of the burnt regions found an area of 4.5% on the facial region, 9% on the thoracic region, 9% on the left lower limb, and 4.5% on the right foot (Figure 1). Supporting laboratory evaluations unveiled hemoglobin levels of 18.9 gr/dL, a hematocrit of 53.3%, an erythrocyte count of 6.4 x 106/µL, a leukocyte count of 15,570/µL, and a platelet count of 440,000/µL. Electrocardiogram findings fell within the state of normalcy (Figure 2). Our medical team concluded a diagnosis of superficial-mid-deep dermal electric burn injury, with an aggregate burn area of 36%.

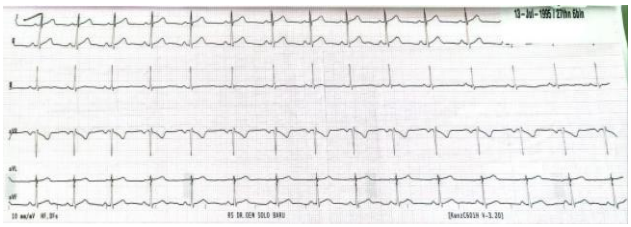

Figure 2. Initial Electrocardiogram Result at The Time of Admission.

Consequently, the patient underwent preliminary fluid management, entailing calculations grounded in the modified Baxter-Parkland formula. This computation yielded a total fluid requirement of 9,360 cc, with the initial half of the required fluid being administered over 8 hour, followed by the remaining volume in the next 16 hours. Additionally, the patient received intravenous medication through 2 doses of 1 gram ceftriaxone injection, 3 doses of 1 gram paracetamol injection, and 2 doses of 50 milligrams ranitidine injection to anticipate his nausea. These therapeutic measures were dispensed within an isolation setting, complemented by a regimen of serial electrocardiogram monitoring.

On the third day of hospitalization, the patient underwent an electrocardiographic examination, unveiling ST-segment elevation in leads II, III, and avF, accompanied by the observation of hyperacute T waves in leads V2 to V4 (Figure 3). Subsequent evaluation included a Troponin I assessment, yielding a result of 4.81 ng/mL. This aggregation of findings prompted the identification of ST-segment elevation myocardial infarction (STEMI) characterized by an inferior pattern elicited by the antecedent electrical injury.

A cardiologist in our medical team meticulously directed the therapeutic trajectory of this patient, instigating a heparin infusion at a rate of 12 units/kg/hour. Supplementary interventions encompassed the administration of 3 doses of 5 milligrams of isosorbide dinitrate (ISDN), alongside a single dose of 75 milligrams of clopidogrel (CPG). Given the intricate diagnostic landscape and the patient's dynamic clinical condition, the medical team decided to transfer the patient to a more specialized medical facility, with consideration to facilitate an elevated continuum of comprehensive management and attentive care, aligning with the evolving exigencies of the patient's situation.

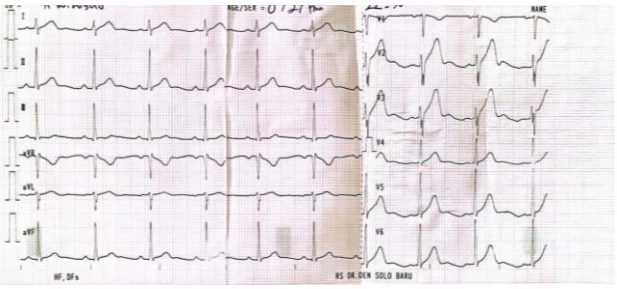

Figure 3. Electrocardiogram Results on The Third Day.

DISCUSSION

Burn injuries are more common in developing countries, with Indonesia estimating approximately 195,000 burn-related deaths each year. While scientific progress in burn treatment has led to a significant increase in survival rates, the mortality rate associated with burns remains elevated.[4]

Electrical injuries, which can occur due to various incidents such as lightning strikes or electric shocks, often lead to significant morbidity and mortality. These injuries are typically accidental and cannot be prevented. Without immediate treatment, they can result in fatal damage, causing dysfunction in multiple organs and tissues, especially in the heart, leading to conditions like arrhythmias and respiratory arrest. The outcome of electrical injuries depends on factors like voltage intensity, the path of electric current, the patient's health, and timely treatment. Early and accurate diagnosis relies on specific laboratory results. Effective management and treatment can reduce or even eliminate losses, especially those caused by complications resulting from electrical injuries.[5]

Electrical injuries encompass a wide range of adverse effects on humans, ranging from superficial burns to potentially fatal arrhythmias.[6] Contemporary research underscores the severity of this impact and reveals that although only 2.2% of electrical injuries treated in emergencies end in death, 42.9% of these have significant consequences. These statistical revelations highlight the increased electrical danger inherent in injuries that traverse the cardiac region, which often leads to a disproportionate increase in mortality rates.[7]

The impact of electrical injury extends beyond the realm of arrhythmias, accelerated hypertension, to even myocardial infarction. Although our understanding of medical intricacies continues to advance, the pathophysiology of electrical current-induced arrhythmias remains a daunting subject.[8] Various simple theories manifest necrotic tissue due to exposure to electric current, as well as modification of the function of the intrinsic sodium/potassium pump in the heart.[9]

A study conducted by Arrowsmith and colleagues screened 145 cases over a 5-year, revealing three occurrences of ectopic need and one occurrence of atrial fibrillation (AF) in the context of cardiac complexity stemming from electrical injury. In addition, this study highlights the relationship between loss of consciousness triggered by electric shock and a greater likelihood of cardiac complications.[10]

In line with these revelations, our case also shows important interactions between electrical injury, loss of consciousness, and subsequent cardiac consequences. The patient in this case experienced rapid loss of consciousness after the electric shock episode, which later manifested as heart disease.

The susceptibility of the heart muscle to ischemia is increased due to impaired blood flow caused by the vascular effects of the electrical burn itself and the effects of the release of vasoactive substances. One hypothesis states that free radicals produced as a result of electrical burns can trigger endothelial dysfunction, leading to arterial vasospasm caused by the release of catecholamines.[11]

Research by Xenopoulos and colleagues suggests that thermally or electrically induced coronary artery vasospasm may contribute to ischemia and acute myocardial infarction.[12] Investigations also suggested the potential for impaired perfusion of the right coronary artery due to ischemia and electrical injury, given its proximity to the anterior chest wall.

A deviant ECG upon admission is said to be the most reliable indicator of potential heart-related complications. Hence, performing an initial ECG for all individuals who have suffered electrical injuries, regardless of the voltage involved is of utmost importance. Patients who have been exposed to electrical injuries and exhibit any of the 4 risk factors defined by ERC: (i) experiencing cardiopulmonary arrest, (ii) losing consciousness, (iii) displaying abnormalities in their electrocardiogram, and (iv) sustaining damage to soft tissues and burns, are categorized as high-risk patients. They necessitate continuous cardiac monitoring in the intensive care unit. Conversely, conscious patients without any of these risk factors do not require inpatient cardiac monitoring following electrical injuries.[13]

Heart problems after electrical injury can occur at unusual times, requiring prolonged monitoring and intervention. Delayed complications such as ST-segment elevation myocardial infarction (STEMI) indicate ongoing inflammation and ischemia even days after the initial injury.[14]

In our case, the clinical assessment indicated burn injuries, and the patient's vital signs were found to be within the expected range. Follow-up ECG evaluations revealed the presence of ST-segment elevation and highly pronounced T waves. On the third day, the Troponin I levels increased, signaling a myocardial infarction (MI) triggered by the electrical injury. Consequently, it became essential to maintain continuous cardiac monitoring for the patient in the intensive care unit.

In the case presented in this article, significant electrocardiogram changes, including ST-segment elevation on the third day, underscore the latent nature of this cardiac problem, thus emphasizing the need for ongoing monitoring and assessment.

The study by Bose and colleagues underscores the importance of detecting acute myocardial damage after electrical burns and advocates assessment of Troponin I levels within 6 hours postinjury to confirm myocardial necrosis. More detail, their research showed a marked decrease in Troponin I levels after 72 hours of electrical injury.[15] In contrast, our case showed a different pattern, where this case showed a substantial increase in Troponin I levels on the third day after electrical trauma injury. The uniqueness of this case highlights the importance of further exploration to determine the optimal time

to evaluate Troponin I levels after electrical injury.

This article shows that electrical burns are a complex case, which requires a collaborative approach. Burn surgeons, cardiologists, and even intensivists must work together to understand the holistic impact on patient physiology. Such interdisciplinary involvement has proven to be indispensable because of the need for careful monitoring and more extensive follow-up to understand and address the complexities associated with delayed cardiac arrest.[15] Our case provides a clear example that an interdisciplinary approach is truly necessary in the management of burn injuries, especially burn injuries. electricity, where this case often causes hidden complications.

The article presents a rare and unusual case who experienced an electrical shock incident while working on a rooftop. This incident led to a complex set of injuries, including electrical burns and cardiac issues, making it an intriguing case for medical professionals. This cardiac complication is not only rare but also potentially life-threatening, making it a critical aspect of the case. The article provides comprehensive clinical and laboratory data, which is essential for both diagnosis and treatment. This includes detailed information on the patient's vital signs, anthropometric data, and laboratory results, enhancing the credibility and thoroughness of the case study. Also, it provides quantitative data, including burn area calculations, laboratory results, and electrocardiogram findings. This data contributes to a thorough understanding of the patient's condition and the medical interventions applied. The article discusses the diagnostic challenges faced by the medical team due to the dynamic clinical condition of the patient. This highlights the complexity of managing such cases and the importance of specialized care.

This article highlights the significance of vigilant patient monitoring, which facilitates the early detection of complications like myocardial infarction. This early discovery enabled medical professionals to initiate timely treatment, potentially mitigating the risk of more severe complications. However, this case report still provides major limitations in that this case report does not discuss the development of the patient's condition and subsequent management. The patient was referred to a more specialized hospital, and as a result, we have no insight into the further development of cardiac tissue damage.

CONCLUSION

Short-term and long-term complications of electrical burns need to be considered. One long-term complication, although rare but posing significant heart-related risks, is myocardial infarction. Careful, continuous monitoring and interdisciplinary collaboration between specialists, such as burn surgeons, cardiologists, and neurologists, are essential for comprehensive patient management, in treating patients in these cases. This case report is only an initial description of the complications of electrical burn injuries, further and larger research is still needed in the treatment of myocardial infarction in patients with electrical burn injuries.

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CONFLICT OF INTEREST

Authors have no conflict of interest to declare.

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None to be declared.

AUTHOR CONTRIBUTION

In crafting this article, ES played a central role by conceiving the concept, conducting the literature review, analyzing clinical data, and drafting the initial manuscript. AF and YP served as crucial editors, offering invaluable input and meticulously reviewing the manuscript to enhance its clarity, coherence, and suitability for publication. Their editorial contributions were pivotal in ensuring the successful publication of this work.

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