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ATRIAL FIBRILLATION FOLLOWING ELECTRICAL BURN INJURY: AN UNUSUAL RHYTHM DISTURBANCE

Emergency Medicine

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ABSTRACT

Electrical injuries are known for causing life-threatening arrhythmias, most often ventricular fibrillation or asystole. Atrial fibrillation (AF) is a rare sequela, with few documented cases in the literature. We report the case of a 49-year-old male who developed sudden unresponsiveness while cleaning a truck and was later found to have new onset AF following probable transthoracic electrical injury. Clinical findings and cutaneous evidence suggested electrical injury as the most probable aetiology. A comprehensive neurological and cardiac evaluation excluded stroke and seizure activity. The patient recovered well with supportive care and rhythm control. This case highlights the need for high clinical suspicion of occult electrical injury as a cause of unexplained AF in atypical presentations and highlights the rarity of AF in such cases.

KEYWORDS

Electrical Injury, Atrial Fibrillation, Transthoracic Current, Arrhythmia

INTRODUCTION

Electrical injuries represent a unique clinical entity with the potential to cause significant morbidity and mortality. Electrical injuries can produce a spectrum of systemic manifestations, including cutaneous burns, cardiac arrhythmias, and neurological dysfunction even in the absence of obvious external trauma or high-voltage exposure.[1]

Cardiac arrhythmias are among the most feared complications. The severity of injury is determined not just by voltage but by current pathway, tissue resistance, and duration of exposure.[2] Ventricular fibrillation and asystole are most frequently encountered after electric shock but atrial fibrillation (AF) which is distinctly uncommon, with reported incidence in some series as low as 0.4%.[3]

In this report, we present a case of new-onset AF in an otherwise healthy adult male following probable transthoracic electrical injury. The clinical course, diagnostic evaluation, and relevant literature are reviewed, with emphasis on the rarity of AF in electrical burns and the importance of thorough clinical examination.

Case Report

A 49-year-old previously healthy male while cleaning a truck became suddenly unresponsive was taken to a nearby hospital where he was noted to have frothing from the mouth. Due to low GCS ,he was promptly intubated for airway protection. The initial ECG revealed atrial fibrillation with rapid ventricular rate, for which intravenous amiodarone was administered. The patient was subsequently referred to our tertiary care centre for further evaluation and management.

On arrival at our Emergency Department , the patient was intubated and sedated. Vital signs revealed a heart rate of 135 bpm with an irregularly irregular rhythm (Figure 1).ECG confirmed atrial fibrillation. Given the acute neurological presentation, a stroke workup was initiated. Magnetic resonance imaging (MRI) of the brain was normal.

Electroencephalography (EEG) was also performed to rule out seizure activity and showed no epileptiform discharges. A detailed metabolic panel including electrolytes, renal and liver function tests, cardiac enzymes, toxicology screen were within normal limits. Transthoracic echocardiography revealed normal cardiac structure and function. On physical examination, two suspicious wounds were noted; one over the left forearm (Figure 2)and another on the anterior chest wall (Figure 3) which were consistent with electric burns of entry and exit wound.

The patient was managed with continued amiodarone infusion and rhythm reverted to sinus rhythm within 2 hours(Figure 4).He was successfully extubated the following day with complete neurological recovery. His cardiac rhythm remained stable post-amiodarone, and no further arrhythmias were observed during the hospital stay.

DISCUSSION

This case highlights a rare but significant presentation of presumed electrical injury manifesting as sudden unresponsiveness and new-onset atrial fibrillation.

Electrical injuries remain a significant cause of morbidity in occupational settings, particularly among individuals in construction, transportation, and maintenance work.[2] Cardiac arrhythmias are among the most feared complications of electrical injuries. The most commonly observed rhythms are ventricular fibrillation or asystole, particularly asystole in high-voltage exposures or when the current traverses the heart [2].

Ventricular fibrillation (VF) and ventricular tachycardia (VT) are the most frequently reported arrhythmias with low-voltage alternating current, as it is more likely to induce fibrillation than high-voltage direct current.[4] In several large reviews, VF was the predominant fatal rhythm, followed by asystole.[1] This is attributed to direct electrical stimulation of myocardial cells during the vulnerable phase of the cardiac cycle, leading to chaotic ventricular depolarization.

In contrast, atrial fibrillation is an uncommon rhythm disturbance following electrical injury and is seldom the presenting arrhythmia. rare. In a review by Kumar et al [3];AF accounted for less than 1% of reported arrhythmias in electrical burn. Atrial fibrillation following electrical exposure has been described in both high- and low-voltage settings, particularly when current traverses the chest.[5] Most cases reported in literature involve immediate onset post-injury, suggesting a direct myocardial electrical insult rather than a secondary physiological response.[5] Atrial fibrillation as a direct result of electrical injury is uncommon but has been reported, particularly in the context of transthoracic current pathways[5,6]. In the absence of underlying cardiac structural disease or metabolic derangements, this arrhythmia is presumed to be directly related to electrical insult.

AF is rare in this setting, with literature between 2020–2025 reporting only a handful of cases worldwide.[7-9] Notably, these recent cases describe low-voltage (220–380 V) injuries resulting in transient AF with rapid ventricular response in otherwise healthy individuals, often resolving spontaneously or after pharmacological cardioversion. Karekar et al[7] documented low-voltage electrical injury leading to AF that converted to sinus rhythm within 6 hours with digoxin tablet. Similarly, Ghosh et al.[8] documented low-voltage electrical injury leading to AF that converted to sinus rhythm with amiodarone within 2 hours. Makharia et al [9] reported a case of transient AF in a healthy adult after domestic electric shock (220 V), resolving within hours. These findings parallel our patient's presentation; new-onset AF after probable transthoracic current flow, normal cardiac structure, and full recovery after intravenous amiodarone.

The rarity of atrial fibrillation in this context makes its occurrence

clinically significant. The proposed mechanisms include:

- Direct depolarization or myocardial irritation by current flow, especially when the heart lies in the current pathway
- Autonomic nervous system imbalance, particularly increased sympathetic drive, following high-stress electrical exposure
- Transient myocardial ischemia from coronary vasospasm or microvascular dysfunction, although this is less likely in patients with normal troponin and echocardiography findings [10]

Our patient, who had no prior cardiac history and normal echocardiographic findings, likely experienced a direct electrical insult resulting in transient atrial fibrillation, successfully managed with intravenous amiodarone and supportive care.

In addition to cardiac effects, neurological manifestations are also common in electrical injury and can be both immediate and delayed. These include transient loss of consciousness, seizures, encephalopathy, and peripheral neuropathies [11,12] Neurologically, electrical injuries may also mimic seizures or strokes due to transient cerebral hypoperfusion, direct neuronal injury, or systemic effects such as hypoxia.

The patient underwent a comprehensive neurological evaluation to rule out concurrent central nervous system injury .Our patient presented with frothing and unresponsiveness, prompting stroke and seizure workup. In our patient, the initial frothing at the mouth and unresponsiveness raised suspicion of seizure or acute cerebrovascular event. However, MRI of the brain and EEG were both normal, ruling out structural or epileptiform causes, suggesting a transient neuro-electrical event or syncope-like episode related to arrhythmia at the time of exposure.[12] This underscores the importance of a comprehensive neurological evaluation in such presentations, as electrical injuries can mimic a variety of acute neurological syndromes.[13]

Importantly, this case highlights how subtle external burn marks when minor or internal, may be easily overlooked can be key to recognizing an electrical injury, especially when the history is unclear. Electrical exposure should be considered in any patient presenting with sudden collapse, unexplained arrhythmias, or signs of cutaneous injury, particularly in occupational or industrial environments.[14]

In this case, the diagnosis hinged on identifying subtle cutaneous burn marks and correlating them with the clinical context. Electrical injuries often present atypically, and clinicians must maintain a high index of suspicion, particularly in occupational settings involving power tools or equipment [8].This case emphasizes the importance of considering occult electrical injury in patients with sudden unexplained unresponsiveness, new-onset arrhythmias, and suggestive skin lesions.

CONCLUSION

While atrial fibrillation is a common arrhythmia in general emergency settings, its occurrence following electrical injury is relatively rare and should prompt clinicians to consider the direction and intensity of electrical current exposure. A high index of suspicion, early rhythm monitoring, and multidisciplinary involvement are essential for identifying and managing these uncommon but potentially serious complications.

Electrical injuries can result in transient neurological dysfunction and cardiac arrhythmias such as atrial fibrillation, even in patients with no prior cardiac history. A high index of suspicion, prompt resuscitative care, and coordinated evaluation by emergency, neurology, and cardiology teams are vital to optimizing outcomes.

Learning Points

Ventricular fibrillation and ventricular tachycardia are the most common arrhythmias following electrical injuries; atrial fibrillation is rare.

Low-voltage transthoracic electrical injuries can precipitate transient AF even in structurally normal hearts.

Careful physical examination may reveal subtle burns suggesting an electrical etiology.

Continuous cardiac monitoring is warranted in all electrical injury patients for at least 24 hours, regardless of initial ECG findings.

Neurological symptoms may be secondary to arrhythmia-related hypoperfusion rather than direct CNS injury.

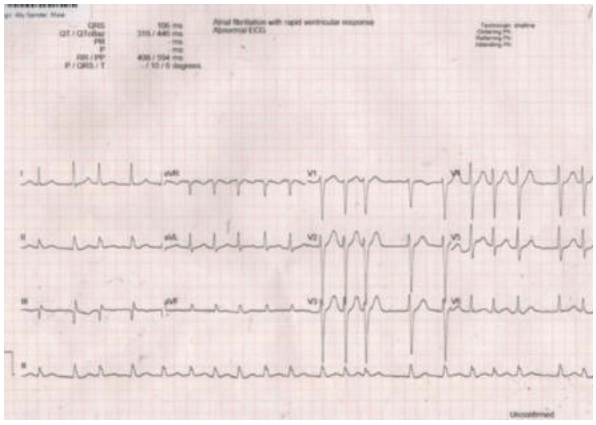

Figure 1 - 12 Lead ECG on Arrival to Emergency Department Showing Atrial Fibrillation with Fast Ventricular Rate

Figure 2 -Clinical Photograph of the Entrance Wound Over the Left Forearm Consistent with Electrical Burn Injury

Figure 3 – Clinical Photograph of the Exit Wound Over the Anterior Chest Consistent with Electrical Burn Injury

Figure 4 – 12 Lead ECG Showing Normal Sinus Rhythm After Amiodarone Infusion of Two Hours.

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