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Case Series

Cardiac Arrest Survival Post-Electrocution – Management in a Low-Resource Emergency Department in Ghana: A Case Series

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ABSTRACT

Introduction

The potential dangers of electrical injuries continue to increase since the commercial availability of electricity. Degrees of electrical injuries range from minor burns to cardiac arrest. Electrocution is cardiac arrest resulting from an electric shock. In Ghana, many electrocution cases are declared dead with little or no resuscitative measures. With the establishment of the emergency department (ED) at Komfo Anokye Teaching Hospital (KATH), such cases within the catchment area are being managed. We sought to describe the management of three (3) cases of electrocution admitted which were resuscitated at the KATH ED.

Case Series

We present three retrospective cases of electrocution involving two adults and one child presenting to the ED of KATH. None of them had any form of cardiopulmonary resuscitation (CPR) at the scene, or en route to the hospital, however, all cases received resuscitative measures of CPR, defibrillation, intubation and other supportive management, and were successfully discharged home in a few days with no major complications.

Discussion

Electrical injuries do occur; however, continuous education and caution should be taken especially whilst using electricity and electrical appliances. Workers with high exposure to electricity should emphasize maximum safety precautions and use of appropriate protective equipment. Home appliances should be well hidden and insulated to protect children. Early recognition of cardiac arrest, immediate initiation of CPR, availability of defibrillators improves outcomes in cardiac arrest post-electrocution.

Keywords: *Electrocution; Electrical Injuries; Cardiac Arrest; Ventricular Fibrillation; Defibrillation.*

INTRODUCTION

Since 1849, when commercial electricity became available, injuries associated with it have been on the rise.[1,2] Electric shock is defined as accidental or intentional contact with an electrical source or energized pathway (e.g. electrical wire) that results in energy transfer from the source to the patient. If it results in cardiac arrest, it is called electrocution.[3] Potential injuries and tissues affected depend on the pathway of the electrical current.[4] Fatal injuries can occur when electrical current passes through the thorax or head.[5]

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The heart is very susceptible to electrical injury and experimental demonstration of some of these adverse effects has been documented as far back in the 18th century.[6] Respiratory arrest, damage to the heart muscle and life-threatening arrhythmia can result from transthoracic injuries.[5]

Cardiac dysrhythmias may result from exposure to low- or high-voltage.[6-8] High voltage is defined as more than 1000volts while a low voltage is less than 1000volts.[7-10] During the vulnerable period of the cardiac cycle (simultaneous to the T wave), ventricular fibrillation can be precipitated by electric current.5 Ventricular fibrillation is the commonest cause of cardiac arrest especially in low voltage current while a high voltage current is more likely to produce ventricular asystole.[10,11] Asystole may be primary or secondary due to asphyxia following respiratory arrest.[5] Resuscitative efforts including immediate cardiopulmonary resuscitation (CPR) is the recommended first aid for cardiac arrest following electrical injury after rescuer has verified scene safety.[8-10]

There is paucity of published work on successful resuscitation of cardiac arrest following electrocution especially in the West African sub-region. In Ghana, prior to the establishment of Emergency Medicine as a specialty, many of such cases presenting with cardiac arrest post-electrocution are declared dead on arrival with little or no resuscitative measures. We report three cases of cardiac arrest following electrical injury, who presented to the Emergency Department (ED) of the Komfo Anokye Teaching Hospital (KATH), Kumasi within a nine (9) month period, which were resuscitated and discharged home with no major complications.

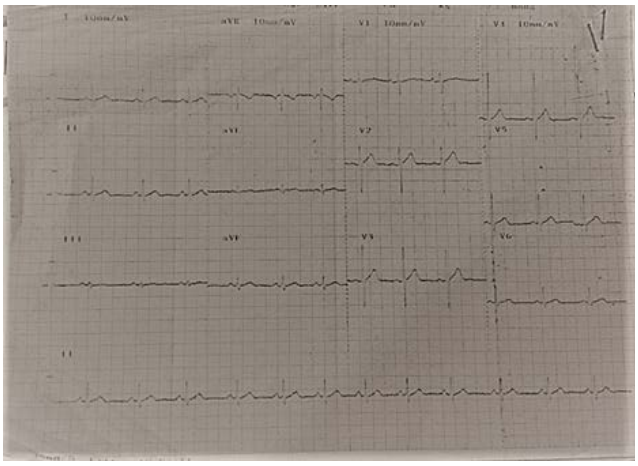
CASE 1

We present a19-year old male welder who sustained electric shock with tetany on accidental contact with naked electric cables at work. He fell supine hitting his head following release from the cables. No by-stander CPR was done. He presented to the ED in cardiac arrest where CPR was started according to Advanced Cardiac Life Support (ACLS) protocol. Cardiac monitor showed ventricular fibrillation. He was defibrillated with 3 shocks at 120J, 200J, and 200J. The rhythm after the 3rd shock showed Torsade's de Pointes and 2g IV MgSO4 was given. The rhythm converted to sinus rhythm with return of spontaneous circulation (ROSC).

He was immediately intubated and placed on a ventilator and continuous sedation, whilst other supportive management was initiated. His significant findings were a circumscribed 1cm right palm burn but no exit wound, occipital scalp laceration, 2+ blood or urine dipstick, elevated creatinine and uncompensated metabolic acidosis. Vigorous fluid resuscitation was done. Other system examinations were unremarkable. Electrocardiogram (ECG), head and cervical spine computed tomography (CT) scans were normal. Figure 1 shows the 12 lead ECG post defibrillation showing sinus rhythm.

Patient was extubated after 36 hours and transferred to the medical ward. Patient was discharged 7 days afterward admission fully conscious. Patient was seen on physician review after 2 weeks with moderate cognitive impairment (mini mental state examination score - 19/30). He was referred to the neurologist.

Figure 1: 12 lead ECG post defibrillation for case 1.

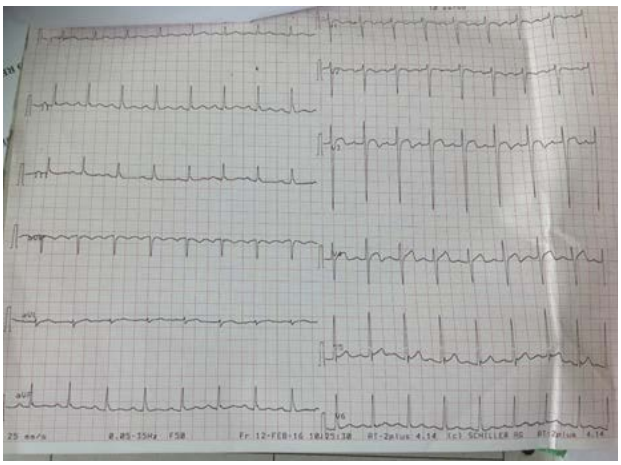


CASE 2

37-year-old male electrician was brought to the ED in cardiac arrest, following electrocution whilst working on the electric cables atop a shop, about 5 meters high. No by-stander CPR was done. CPR was started immediately according to ACLS protocol. Cardiac monitor showed ventricular fibrillation and two (2) biphasic defibrillation shocks were delivered at 200J. Patient was quickly intubated and put on a ventilator, after ROSC. Continuous sedation was done with IV Midazolam and Morphine.

General examination was normal with no obvious burn areas seen. Initial urinalysis was glucose 1+, blood- trace and proteins 3+. ECG showed a normal sinus rhythm with HR of 99bpm post defibrillation as shown in Figure 2.

Figure 2: 12 lead ECG post defibrillation for case 2.



Samples were taken for routine labs. Creatinine Kinase was five times elevated above the normal. Liver enzymes were slightly raised. Electrolytes, urea and creatinine were within normal ranges. Aggressive

fluid rehydration was continued. Repeat urine dipstick showed blood 2+ and protein 1+. More fluid hydration was done with good urine output.

Patient was extubated 20 hours after admission and moved to the medical ward. Head CT scan was normal with patient fully conscious. General examinations during ward reviews were normal. Repeated labs and ECG were normal. Patient was discharged on Day 4 of admission and referred for follow up reviews at the physicians' clinic and subsequently discharged.

CASE 3

A 16-month old female child was brought to the ED unresponsive by her mother. She was said to have held a plugged electrical extension cord and had tetany for about 5 minutes. The electrical switch was turned off and child brought in cardiac arrest.

CPR was started according to Pediatric Advanced Life Support (PALS) protocol. Cardiac monitor showed ventricular fibrillation. There was ROSC after a second defibrillation shock at 40J, with sinus tachycardia. Patient was immediately intubated with the available ET tube size 4 cuffed, started on continuous sedation with morphine and midazolam infusion and pressor support (dobutamine); and transported to Pediatric Intensive care Unit (PICU) where she was re-intubated with ET tube size 4 uncuffed. Her initial lab results showed hyperkalemia (K+-6.2mmol/l) and management was started. Other supportive post-resuscitation management was instituted.

The child was extubated 24 hours after admission but developed a post-extubation stridor for which she was nebulized with adrenaline. Patient was started on antibiotics on account of persistent fever and transferred to the pediatric ward. Subsequent reviews and repeated lab results were normal. She was discharged from the ward on Day 5 of admission. Her one week follow up review was normal and patient was subsequently discharged.

DISCUSSION

According to the European resuscitation guidelines, in adults, most electrical injuries occur at the workplace with high voltage whiles in children, the injuries occur at home where the voltages are low.[5] The electrocution of the two adult patients in this case series occurred at work whiles that of the child was at home by a naked-wire. It is important that high safety standards and protective equipment are maintained at workplaces especially in places where electricity is a major component.

It is important that all power supply is switched off and any potential fires are put out before any rescue is attempted. High-voltage (above domestic mains) electricity can arc and conduct through the ground for up to a few meters around the scene.[5] In all cases, the power had to be turned off before rescue was done. This is very important and must be observed in all cases of electrical injuries. This is to prevent rescuers from becoming victims themselves.

Significant of note throughout these case series is the absence of any form of by-stander CPR at the scene or en-route to the hospital and the absence of transport by an ambulance. By-stander CPR is recommended for all cases of unresponsiveness especially in the case of electrocution after verified scene safety.[5] In developing countries, the concept of Basic Life Support (BLS) or by-stander CPR has not gained much prominence,[12] therefore majority of unresponsive patients or victims of sudden collapse in these countries, presenting to the ED do not receive any form of CPR on scene or en-route the hospital.

Out-of-hospital cardiac arrest has a mortality of about 90% and CPR has been shown to save lives as it increases the chance of survival up to three times when administered soon after cardiac arrest.[13] According to 2014 data, when bystander CPR was done, survival was nearly 45% for out-of-hospital cardiac arrest victims.[13] Although our patients arrived on time to receive advanced life support measures, this is sadly not the case for many patients, due to possible factors such as lack of CPR skills and delays in transporting patients to hospitals.

Ventricular fibrillation is usually caused by AC whiles asystole is caused by DC both of which are fatal.[14] The treatment for ventricular fibrillation is defibrillation using a manual defibrillator or an Automated External Defibrillator (AED) for out of hospital cardiac arrest. Asystole is managed according to Advance Cardiac Life Support (ACLS) guidelines.

All our patients presented in cardiac arrest, CPR was initiated immediately, with all 3 cases having initial rhythms of ventricular fibrillation which converted to sinus rhythm, after receiving defibrillatory shocks. KATH ED, where these patients presented is equipped with a manual defibrillator, however, many hospitals within our region lack manual defibrillators and other advanced life support equipment to manage such cases and could have been pronounced dead on arrival. This necessitates the need for BLS/ACLS trainings and availability of equipment, particularly for practitioners who manage emergencies.

Post-Electrocution Injuries and Management

Electricity can also cause conduction abnormalities and direct trauma to cardiac muscle fibres.[15] Known cardiac effects of electrical injury include acute myocardial necrosis, myocardial ischemia secondary to coronary artery spasm (with or without necrosis), heart failure, dysrhythmias (atrial and ventricular), reversible cardiomyopathy, hemorrhagic pericarditis, acute hypertension with peripheral vasospasm and anomalous, non-specific ECG alterations.[6,11,16,17] Electrical shock survivors can develop a sequelae arrhythmia such as sinus tachycardia and premature ventricular contractions (PVCs),[15] hence a serial ECG and follow up reviews should be arranged post-discharge from the hospital. All our patients had post discharge reviews at the outpatients' clinic.

Electrical energy can cause damage to the tissues directly, alter the resting potential of the cell membrane and precipitate tetany. This tetanic contraction of the skeletal muscles results in inability to "let-go" of the electrical source.[5] Our 3-cases had tetany and had to be broken free of the contact source. Paralysis of the respiratory muscles or the respiratory centre may cause respiratory arrest.[5] Rhabdomyolysis can result from extensive tissue damage which can progress to renal failure if not managed adequately,[15] In our cases, they had evidence of myoglobinuria, managed with adequate fluid resuscitation, thereby preventing the onset of acute renal failure. Aggressive and prolonged CPR should

be attempted for victims of electrical injuries limited to ventricular arrhythmia and respiratory paralysis especially young people who may have less comorbidity, as such higher chance of survival.[15]

Electrical current can cause thermal burns when it passes through the skin and deep tissues.[15] Absent external burns does not exclude electrical injury, in the same way the severity of the external burns does not indicate the severity of the electrical injury.[4] The burns are usually worse at the point of contact which is usually the hands or head and the ground contact (usually the feet).[15] Mechanical injury with direct trauma including fractures and dislocations can result from falls or violent muscle contraction. Hitting the head on the ground or object can cause traumatic brain injuries.[4,15] Our first patient sustained a palm burn as well as an occipital laceration when he fell down. These wounds were treated, and a CT-scan was done to assess for intracranial injuries.

Table 1 is a summary of guidelines for the management of electrical injuries according to the European Resuscitation guidelines.[5]

Table 1. European Resuscitation guidelines for the management of electrical injuries

• Rescuers in electrical injuries should practise awareness of scene safety before rescuing victims
• Basic and advanced life support should be done for all patients including c-spine immobilization and early intubation if needed
• Victims may need ventilator support when there is paralysis of the respiratory muscles particularly, after high voltage
• Ventricular fibrillation should be treated with rapid defibrillation. Other arrhythmias such as asystole should follow standard protocols
• Burning clothes should be removed to prevent further thermal injuries
• Aggressive fluid therapy should be done in cases of severe tissue destruction. Monitor urine output to prevent acute kidney damage
• Surgical intervention should be considered for patients with severe thermal injuries
• Consider early surgical intervention in patients with severe thermal injuries
• Fasciotomy may be indicated for severe tissue injury causing compartment syndrome

All our patients were managed for a few days in the hospital and discharged. Follow-up reviews at the outpatient clinic were also unremarkable. Although morbidity and mortality from electric shock is high, patients who respond to immediate treatment have an excellent chance of recovery as evidenced by our case series.

CONCLUSION

Electrical injuries do occur; however, continuous education and caution should be taken especially whilst using electricity and electrical appliances. Workers with high exposure to electricity should emphasize maximum safety precautions and use of appropriate protective equipment. Home appliances should be well hidden and insulated to protect children.

Despite precautions, electrical injuries are still inevitable; therefore, medical practitioners need to be adept at the resuscitation, management and follow-up of such patients. Health facilities especially casualty units, accident and emergency centers and emergency departments should be equipped with basic resuscitation equipment such as defibrillators, which were particularly central in the management of the cases presented.

Early recognition of cardiac arrest, immediate initiation of CPR, availability of defibrillators improves outcomes in cardiac arrest post-electrocution. Also, although the outcomes were favorable in these cases (with no by-stander initiated CPR), they highlight the necessity of Basic Life Support (BLS) training for the general population.

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