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The treatment challenges and limitation in high-voltage pediatric electrical burn at rural area: A case report

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ABSTRACT

INTRODUCTION: Although rare, electrical injury in pediatrics is potentially life threatening and has significant and long-term impact in life. It is challenging to manage such cases in rural areas.
PRESENTATION OF CASE: A fully conscious 13-year-old boy was admitted to the emergency room after being electrocuted by high-voltage power cable, with superficial partial thickness burn over right arm, trunk, and left leg (26 % of total body surface area). Tachycardia and non-specific ST depression was found on ECG examination and was diagnosed with high-voltage electrical injury. Treatments were based on ANZBA algorithm with several modifications, i.e., administering lower concentration of oxygen with nasal cannula instead of non-rebreathing mask as well as Ketorolac and Antrain® for analgesic instead of morphine.
DISCUSSION: Different choices of treatments were given due to limited resources. Despite possible cardiac and renal complication, further tests could not be done. Fortunately, after strict monitoring, no signs of abnormality were found. We used silver sulfadiazine, Sofratulle® and dry sterile gauze as a dressing of choice following immediate surgical debridement. The patient was observed daily through 7 days of hospitalization and followed-up for 1 year, achieving normal physiologic function of the affected area but unsatisfactory esthetic result.
CONCLUSION: Lack of infrastructure, drugs, and trained personnel are some of the challenges that still exist in most rural areas. Thus, implementation of available standardized guidelines such as ANZBA, and giving similar training to personnel as well as providing feasible equipment followed by strict monitoring for the patient are needed to achieve maximum results.

1. Introduction

Prevalence of electrical injury in people younger than 18 years old is 4.6 % based on data from the Indonesia's National Burn Center, Cipto Mangunkusumo Hospital [1]. Even though the percentage is considered low, electrical injury possesses potentially severe damage which can cause permanent changes to appearance, function, and independence [2]. It can cause significant and long term impact in life, especially in children [3]. Despite the damage, with the support of skilled personnel and the right treatment, their functional outcome can be maximized [2].

East Nusa Tenggara Province ranks among the lowest in District Own-Source Revenue in Indonesia [4], which may have stalled the general development of the province. Moreover, inadequate facilities in hospitals, complicated geographical conditions, and limited available transportation are some of the problems that might complicate the management of complicated injuries such as electrical burn, moreover in the pediatric population. Our patient was treated in one of the community healthcare which also had limited facilities, human resource, and choice of treatment modality. This paper aims to elaborate and to evaluate how to manage such a patient or injury in an isolated area with limited available resources. This paper has been reported in line with the SCARE 2020 criteria [5].

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Fig. 1. Wound on presentation at the emergency unit.

Fig. 2. Entry wound on fingers of right palm.

2. Presentation of case

A 13-year-old male patient was brought into the emergency unit by private vehicle 30 min after being electrocuted by a 20,000 V wire without any first aid applied. On arrival, the patient was alert, oriented, and hemodynamically stable. Past medical history and family history were uneventful. The burn wounds, classified as superficial partial thickness burn, involved the right arm, trunk, and the left leg. The total burn area was 26 % total body surface area (TBSA) (Fig. 1) with identifiable entry wounds (Fig. 2) and not identifiable exit wound. No compartment syndrome was identified clinically. The emergency treatment using the algorithm from Australian & New Zealand Burn Association (ANZBA) was applied by the emergency room general practitioner with focus on emergency treatment and stabilization. The collar neck was not administered as there was no history of falling, no injury above the clavicle, and the patient could move his neck without any pain. Oxygen (3 L/minute) was then administered using nasal cannula since a non-rebreathing mask (NRM) was not available, and clothing and accessories from the patient's body were removed.

Fig. 3. Wound after surgical debridement at operating room.

Fluid resuscitation with Lactated Ringer's solution was then performed according to the modified Parkland-Baxter formula without maintenance fluid, and hourly urine output via urinary catheter was measured and maintained to 1 mL/kg/hour. Intravenous ketorolac was used as the analgesic with intravenous ceftriaxone as the prophylactic antibiotic. Tetanus prophylaxis was not administered because of clean wound and complete vaccination status. All tests were performed - except for unavailable ones i.e., arterial blood gas, troponin, lactate dehydrogenase, creatine phosphokinase, and urine myoglobin. The following abnormal results were detected from: routine blood examination (leukocytosis 16.10×10^9/L, SGOT 146.8 U/L, SGPT 58.5 U/L, mild hypokalemia 3.4 mmol/L) and urinalysis (yellow, positive blood (+++), erythrocyte 20–25 cells per high power field). Daily serial electrocardiography (ECG) was performed following sinus tachycardia with nonspecific ST depression on lead II and aVF finding. Nasogastric tube (NGT) was not administered. Ultrasound or Arterial Doppler examination was unavailable and thus unable to perform, hence constant monitoring of oxygen saturation of the right upper extremity (the affected limb) using pulse oximetry was done to ensure adequate perfusion.

Immediate surgical debridement was performed by an attending general surgeon under general anesthesia (Fig. 3) and the wound dressing was changed within 3 days. The analgesic was changed from ketorolac to Antrain® (metamizole/dipyrone) to achieve optimal analgesia prior to dressing change. Painful gran-

Fig. 4. Day 11: Wound with complete epithelialization.

Fig. 5. 1 year: significant wound healing process with several hypopigmented areas – unsatisfying aesthetic result.

ulation tissues with minimum slough and some bleeding were detected. Serial ECG was stopped on the third day after the patient resumed normal profile. Neither systemic infection nor dysfunction of internal organs was found during the patient's stay in the hospital. The patient was discharged at the 7th day of hospitalization as the patient remained stable.

The patient resumed wound care in the surgery outpatient setting with the same attending surgeon. Wound dressing consisted of silver sulfadiazine including framycetin sulphate BP 1% (Sofra-tulle), and dry sterile gauze was applied, until complete epithelialization was achieved on the eleventh day (Fig. 4). Daily use of elastic bandage with liberal amount of olive oil (Mustika Ratu™) was advised soon after complete epithelization.

On signs of mild depression, psychiatric consultation was encouraged, but refused by the patient. During the 6-month-follow up, significant wound healing process with normal pigmentation was observed. There were no significant motoric, sensory, or autonomic dysfunction; neither hypertrophic scar nor contracture on 1-year post-injury (Fig. 5). However, several hypopigmentation could be seen in the central part of the wound, which made the aesthetic result unsatisfying.

3. Discussion

This case report reveals many aspects of electrical injury management in a hospital with limited resource. These aspects, while fully reasonable and expected, require attention and effort of the healthcare personnel to construct some modifications in order to achieve the best possible treatment plan for patient's safety and wellbeing despite the limitations. In this case, ANZBA was used as the guideline while some modifications were performed for the aspects which were unable to fulfill. The best possible alternative devices or procedures were utilized with the aim of achieving optimal wound healing and reducing the patient's morbidity and mortality.

First aspect is about the first aid for burn injury. Immediate copious running water was not applied due to inadequate knowledge, whereas copious irrigation will limit the severity including the size of the injury [6]. The cost consideration also affected the decision for the amount of saline used for irrigation, and this might contribute to under treatment despite the physician's adequate knowledge.

The second aspect is about oxygenation. According to ANZBA, the patient should have been oxygenated using NRM, but since it was unavailable, we used nasal cannula as the alternative and fortunately the SpO_2 was maintained at $\geq$ 95 %. The third one is about pain management which is crucial as burn injury is painful. As there was no procurable ventilator, we replaced intravenous morphine with another analgesic, yet pain assessment was performed daily until the pain was tolerable.

The fourth and perhaps the most crucial point is the fluid resuscitation. In contrast with ANZBA, Advanced Trauma Life Support (ATLS) 9th Edition book used at the time did not mention any maintenance fluid when resuscitating pediatric burns [7]. ATLS was commonly held as the basic guideline for all trauma by most emergency doctors who might not know that there is a specific guideline e.g., ANZBA for burns. Therefore, in accordance with ATLS guideline, the emergency unit doctor did not give any maintenance fluid to the patient. This might hamper the resuscitation effort and put the patient in risk of shock, but we conducted strict monitoring of the patient's vital signs in pediatric intensive care unit and the patient resumed normal profile during his stay.

The fifth point is about referral. According to ANZBA guideline electrical injury should ideally be referred to a burn center [2], yet the nearest city with such facility is approximately 1600 km and even though it could be reached by plane in 2 h, the Universal Health Coverage of Indonesia does not cover any transfer by plane, therefore the patient had to be treated with limited resource and facility.

Our sixth and final point is about the diagnostic and treatment modalities. Even though burn injury diagnosis did not need any sophisticated modalities, but the definitive diagnosis for the accompanying complications such as myocardial injury and myoglobinuria could not be performed owing to the fact that several tests were not available, including arterial blood gas, troponin, lactate dehydrogenase, creatine phosphokinase and urine myoglobin [8]. We could only perform urinalysis, and although erythrocytes were present, no color change indicated an unlikely possibility of myoglobinuria [9]. We suggest that it was due to blood contamination from accidental urethral injury when placing the urinary catheter.

In electrical injury case, Ultrasound or Arterial Doppler examination is crucial to ensure adequate perfusion of the affected part of the body, as electrical injury may cause great damage to the vascular and musculature with the risk of compartment syndrome. Unfortunately, our hospital did not have such facility, and the patient was not able to be referred due to cost issue. As an alternative, we measured and monitored the oxygen saturation of the affected limb constantly using pulse oximetry and from admission to discharge, the patient resumed normal oxygen saturation.

As for the treatment modality, NGT should have been administered during first aid phase to prevent gastric dilatation [2]. However, in consideration of the cost issue and lack of patient's cooperation, supported by no clinical evidence of gastroparesis, we decided not to insert an NGT and made sure the patient received early oral feeding within 48 h of injury. For the wound dressing, we preferred to use silver sulfadiazine combined with Sofra-tulle® as a study from Karyoute SM showed that Sofra-tulle® used as wound dressing in this case could decrease the rate of infection in burns of developing countries [10]. While this kind of dressing may not be the most ideal dressing for burn wound, cost issue was the main consideration. The maximum BPJS coverage for severe burn injury in East Nusa Tenggara as region 4, particularly for the third-class ward patient in type C hospital, is Rp 6.466.400 [11], equivalent to 470 USD. It is obvious that the insurance would not cover the gold standard treatment. An estimated fee needed to be paid for non-insurance holders in our hospital involving the intensive care unit, drugs, and debridement surgery is double the amount, not yet including the doctor's visit and dressing change fee. Sofra-tulle® and silver sulfadiazine combination was the best possible wound dressing in our setting supported by clinical evidence.

Inadequate management of severe burn in this case is due to the fact that most of our emergency department personnel have not had the chance to participate in burn injury management training due to the location which is far away from the big cities where such training is usually conducted. Lack of prevention programs, inadequate burn care facilities, lack of resources, lack of trained staff, and poor infrastructure as well as coordination also contribute to the difficulty and are the dilemmas faced by most low-middle income countries (LMICs) [12].

But we believe that, as important as unveiling these obstacles, the outcome of the modified management should also be taken into consideration. In this case, the patient's final outcome was better than what could be expected in such circumstance. Significant wound healing with normal pigmentation was observed on the 6th month after the incident. There were no significant motoric, sensory, or autonomic dysfunction; neither hypertrophic scar nor contracture on 1-year post-injury Even though several hypopigmentation could be seen in the central part of the wound, which was also expected, the only drawback in this case was only the aesthetic aspect/appearance, yet no such disruption of function was found. Considering the type and severity of the injury in a limited facility, perhaps it was the best outcome possible for such patient in such circumstance. Based on the interview with the patient and his family, they felt satisfied and grateful for the received treatment and free routine follow-ups home visit from the authors which had helped them saving cost and time while getting appropriate care and advice. Since the scars consisted of areas mostly covered by clothes, the patient did not feel significantly disturbed by the scars and were quite content with the progress one year after the accident.

4. Conclusion

Inadequate first aid application showed there is still a lack of burn prevention programs in the community. In tackling the challenge of managing pediatric electrical burn in a rural area with limited resources and facilities, there is a need for acknowledging and maximizing the implementation of available standardized guidelines ANZBA by giving homogenized training to personnel as well as providing feasible equipment, and then followed by strict monitoring for the patient. In addition to adequate burn management for life saving and good wound healing, the focus should also be about burn rehabilitation, psychosocial needs and any complaints needing expert opinion in an outpatient setting.

Declaration of Competing Interest

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Ethical approval

The study is exempt from ethical approval in the institution where the study was conducted.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

Adi Basuki: study concept and design, data collection.
Agustini Song: data collection, writing the paper.
Nabila Viera Yovita: data analysis and interpretation, writing the paper.
Kevin Leonard Suryadinata: study concept and design, data analysis and interpretation.
Asian Edward Sagala: study concept and design, data analysis and interpretation.

Registration of research studies

Clinicaltrials.gov, NCT04772573 available at: https://clinicaltrials.gov/ct2/show/NCT04772573

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