Open Access Maced J Med Sci **electronic publication ahead of print,**
published on May 18, 2018 as https://doi.org/10.3889/oamjms.2018.206

ID Design Press, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences.
https://doi.org/10.3889/oamjms.2018.206
eISSN: 1857-9655
Clinical Science

Electrical Burns and Their Treatment in a Tertiary Hospital in Albania

Gentian Zikaj[1*], Gezim Xhepa[2], Gjergji Belba[3], Nardi Kola[4], Sokol Isaraj[4]

[1]Institute of Public Health - Epidemiology and Biostatistics, 80 Aleksander Moisiu Str, Tirana, Albania; [2]Department of Morphology, Clinic of Plastic and Burn Surgery, University Hospital Center "Mother Teresa", Faculty of Medicine, Tirana, Albania; [3]General Surgery, University Hospital Center "Mother Teresa", Tirana, Albania; [4]Service of Burns and Plastic Surgery, UHC Mother Tereza, Rruga e Dibres Nr 370, Tirana, Albania

Citation: Zikaj G, Xhepa G, Belba G, Kola N, Isaraj S. Electrical Burns and Their Treatment in a Tertiary Hospital in Albania. Open Access Maced J Med Sci. https://doi.org/10.3889/oamjms.2018.206

Keywords: Electric burns; Upper extremity; Complications; Treatment; Fasciotomy

***Correspondence:** Gentian Zikaj. Institute of Public Health - Epidemiology and Biostatistics, 80 Aleksander Moisiu Str, Tirana, Albania. E-mail: gentianzikaj@yahoo.com

Received: 19-Mar-2018; **Revised:** 13-Apr-2018; **Accepted:** 14-Apr-2018; **Online first:** 18-May-2018

Funding: This research did not receive any financial support

Competing Interests: The authors have declared that no competing interests exist

Abstract

INTRODUCTION: The electrical current burns represent a very aggressive pathology that leaves many functional and aesthetic consequences.

AIM: To evaluate the epidemiology of electrical burn injury and its associated complications and treatment.

MATERIAL AND METHODS: Demographic data, aetiology, burn percentage and other measures related to electrical burn injury of 33 electrical burn patients in a tertiary hospital during the years 2015-2017.

RESULTS: The mean age of patients is 31 (± 8.3) years old with a predominance of males (94%). The vast majority of injuries occurred at work ($p < 0.01$), superior extremities were more affected with hand (21.2%) and fingers (18.2%) being the main point of contact ($p < 0.01$). Muscular fasciotomy was performed in all patients who were treated surgically (n = 27), amputation was performed in 11 (40.7%) of cases, but amputated sites were more than the number of patients affected. Myoglobinuria (39.4%), cardio-respiratory distress (12.1%) contusion cerebri (6.1%), were the complication encountered in patients.

CONCLUSIONS: Electrical burn injuries are still amongst the highest accident-related morbidities. Educating the population about the dangers and hazards associated with improper use of electrical devices and instruments is imperative.

Introduction

The electrical current burns represent a very aggressive pathology that leaves many functional and aesthetic consequences. It remains one of the most disabling accidents in the nosology of burns and plastic surgery because of the aesthetic and functional consequences in the surviving patients [1] [2]. The very aggressive and often disabling damages not so much lethal (after overcoming the first post accidental period), transform this burn in a problematic pathology and always enquiring.

Classification of electrical injuries is typically divided into low-voltage (LV < 1000 volts) and high-voltage (HV > 1000 volts), as well as by whether electrical current flows directly through the body vs a thermal injury caused by electrical flash. The electrical burn includes the tissue damages caused by the conduction of the electricity through the morphological structures of the organism.

This pathology is different from the thermal burns caused by the electric arch which because of the high temperature (around 2500ºC) causes wounds that might be misinterpreted like tissue damage from the electric current burns. The difference between these damages is significative because the thermal burns from the electric arch are

not followed by debilitating consequences but are limited to the local damages. Electrical injuries are uncommon but potentially devastating and constitute approximately 0.04 to 5% of admissions to burn units in developed countries, and up to 27% in developing countries [1] [2]. Electrical injuries in the adult population primarily affect men, are most often work-related, and are the fourth leading cause of traumatic work-related death [3]. Both morbidity and mortality in electrical injuries are relatively high and have physical and psychological short-term and long-term sequelae [4] [5]. This study was conducted to evaluate the epidemiology of electrical burn injury and its associated comorbidities in a tertiary hospital, to elucidate the burden of this type of injury and other burn-related complications for better management, prevention and treatment of patients.

Material and the Methods

This is a retrospective study including 33 patients with electrical burns hospitalised in the intensive therapy unit in the "Burns and Plastic Service" clinic of the University Hospital Center "Mother Teresa" during the years 2015-2017.

Demographic information and the mechanism of injury (high voltage *vs* low voltage), complications, hospitalisation period, surgical interventions and severity of electrical injuries were recorded as well as acute and late complications, the degree of disability the degree of correlation of the wound surface size with the grade of the pathology and treatment strategy.

This study was accepted by the ethical committee of Tirana University of Medical Sciences, Tirana, Albania. All continuous variables were presented as means ± SD, and the frequencies of categorical variables were presented as percentages. Chi-square test was used to compare the proportions of categorical variables and student *t*-test to compare the mean of continuous variables. A P value < 0.05 was considered significant.

Results

Sociodemographic characteristics of patients are presented in Table 1. The mean age of patients is 31 (± 8.3) years old with a predominance of males (94%). The most commonly affected were the 3-40 year age group (28.6%) and 41-50 year (30.3%) age group. The frequency of patients in other age groups was lower.

Table 1: Sociodemographic characteristics of patients

Variables	N	%
Gender		
Female	3	6.0
Male	30	94.0
Age, Mean (SD)	31 (± 8.3)	
Age group		
<10	5	15.2
11-20	3	9.1
21-30	4	12.1
31-40	7	21.2
41-50	10	30.3
>50	4	12.1

Patients affected by high voltage electricity outnumbered the low voltage group (Table 2). The vast majority of injuries occurred at work ($p < 0.01$) superior extremities were more affected with hand (21.2%) and fingers (18.2%) being the main point of contact ($p < 0.01$). Foot (12.1%) was more affected in inferior extremities, and in 15.2% of patients in other regions were involved (head, thorax, abdomen).

Table 2: Clinical characteristics of patients

Variables	N	%
Electric power		
High voltage	27	81.8
Low voltage	6	18.2
Injuries		
At home	5	15.2
At work	28	84.8
Point of contact		
Upper extremities		
Fingers	6	18.2
Thumb	3	9.1
Hand	7	21.2
Forearm	3	9.1
Arm	2	6.1
Lower extremities		
Foot	4	12.1
Below knee	2	6.1
Above knee	1	3.0
Other regions	5	15.2
Wound surface		
< 10%	16	48.5
21 – 30%	12	36.4
>30%	5	15.2

The average hospital stay, was higher M = 58.1 (± 24.3) in 27 (81.8%) patients with high voltage injury who underwent in surgical treatment for ectrocombustio in comparison to low voltage injury patients M = 7.5 (± 2.5) in whom the treatment was conservative for thermal burn, 6 (18.2%), ($p < 0.01$). Muscular fasciotomy was performed in all patients who were treated surgically (n = 27), amputation was performed in 11 (40.7%) of cases, but amputated sites were more than the number of patients affected (n = 15) (Table 3).

Table 3: Surgical treatment technique

Surgical technique	N	%
Muscular fasciotomy	27	100.0
Amputations	11	40.7
Free plastic post necrosectomy	16	59.3
Free plastic post-amputation	5	18.5

The most common site of amputation was the fingers. Most of these injuries occurred during spring and summer. Myoglobinuria (39.4%), cardio-respiratory distress (12.1%) contusion cerebri (6.1%), were the complication encountered in patients.

Discussion

The electrical burns occur mainly among males 94% in our study. The cause of this high involvement of this sex implies the high mobility of the children of this sex and the risk-taking behaviour whereas among adults males are involved more in the professions such as construction and factories. Other studies have reported similar results with our study [6] [7] [8].

Also in 25% of the cases, alcohol consumption was the cause of the accident. In total, 35% of accidents occurred at night shifts. The most common cause of electrical burn injury was electrical contact. Attention has been given in this study also the differential between an electrical burn (electrocombustion) from the electric power and a thermal burn from the electric arch, which often confuses the diagnosis at the moment of the hospitalisation in the emergency department. This differentiation does have not only theoretical considerations but also practical in the further management of the pathology. Practically, the thermal burn from the electrical arch, it is characterised by a low voltage and causes a relatively superficial wound because of the short time acting on the tissue. In our study, the six patients with thermal burns are treated conservatory, *per primary*, with epithelization. On the other side, the thermal electric burns, do not manifest vital complications in the acute phase, and they do not affect the metabolic balance of the patient [9] [10]. Considering the extensive damage these burns manifest, the electric burns require careful management of the pathology since the first moment due to the serious acute complications that might follow. Myoglobinuria was one of the acutest complications encountered in our study. 39.4% of patients have manifested this symptom for 48-96 hours. Another severe complication involved by cardiac rhythm disturbances and respiratory acidosis, with pulmonary fields hypoventilation in 12.1% patients. Regarding the anatomical part, we note that the most frequent point of contact was the upper extremities, as the most active ones. In 63.6% of the cases at least one of the contact points is on the upper extremities. Theoretically, the tissue damage is greater in the entry point and smaller on the exit point [11] [12]. Nowadays we are moving more and more towards naming of these points like contact points due to the aggressiveness of the tissue damage which doesn't always discriminate which is an entry point or an exit point. Even in the clinical practice, it is difficult the morphopathological differentiation of the nature of the tissue damage to determine the entry point without a careful history of the accident to define the damage mechanism [13] [14] [15]. In this study, we found two thoracic contact points and one occipital. The thoracic cage is completely bony and presents a high resistance towards the electric current, and this is converted into a high heat production towards the tissues resulting very revitalizing. The same phenomena happen on the skull, where the cranium is very close to the surface and is covered by a very thin layer of soft of tissues, very fragile towards the heat produced by the electric current. The most susceptible to damage remain the entry points in the extremities, where the high energy produced by electric current results in severe damages in the small sections of the tissue. The cause of these lesions in the small section structures is the high resistance they display towards the electricity. Patients with high voltage injuries underwent surgical treatment. Careful management helps in preventing post-combustion complications. The sparing of damaged structures from the compartment syndrome requires surgical intervention within the first 24 hours [16]. Muscular fasciotomy for the prevention of the metabolic necrotic damage progression remained imperative and was applied in 100% of the cases. This is followed by total necrosectomy or amputation as soon the metabolic and hemodynamic equilibriums was reached. In this study, the amputation was applied in 40.7% of patients in the interval 72-120 hours after the accident. In five of the patients, the amputations were very disabling while in the rest of them the amputations were only in the level of fingers. Nevertheless, even in the cases of minor amputations, post-combustion fibrosis has contributed to the complete loss of function of the affected limb. Total necrosectomy was applied in 59.3% of the patients. The tissue damages were closed with free plastic intervention after 10-21 days, thirteen cases post necrosectomy and in three cases post-amputation in upper extremities. The high frequency of the free plastic technique, mostly on superior upper extremities increases the degree of the disability because of the aggressive fibrosis, mostly in the level of the articulations [17] [18]. The most efficient period for the above interventions was during the first week after the accident. Noteworthy in this study were the late complications of these accidents such as anaemia and haemorrhage which was treated surgically.

The surface of burn wounds varied patients from 3% to > 30% of body surface with a median of 15.8%. Also, the hospital stay varied widely, depending on the burn surface from the electric arch. The electric burn is one of the most severe and expensive pathologies, with a long hospital stay and several surgical procedures. The mean hospital stay for surgically treated patients was 58.1 (± 24.3) days, except for patients with amputations and the patient with burns in the visceral cranium, whose stay was longer. The mean hospital stay for six patients with thermal burns from the electric arch was 7.5 (± 2.5) days, hinting the mild damages of this pathology. Similar findings were reports by other authors [19]. Patients experienced significant levels of emotional

distress. Anxiety was more common in patients with high-voltage electrical injuries [20]. The treatment aims to achieve the skin cover to prevent infection and to allow early mobilisation. Adult electrical injuries usually occur as an occupational hazard, whereas children are primarily injured accidentally. The spectrum of electrical injury is very broad, ranging from minimal injury to severe multiorgan involvement, with both occult and delayed complications and death. If signs and symptoms of compartment syndrome exist, decompression is necessary. Escharotomy and fasciotomy were performed in the upper limb and trunk relieving compartment pressure in upper limb and improving ventilation. Amputations become necessary when there is damage to nerves, tendons, skin and all blood vessels. Current passing through the heart or thorax can cause cardiac arrhythmias and direct myocardial damage, whereas passing through the brain can result in respiratory arrest seizures, direct brain injury and paralysis. Current passing close to the eyes can cause cataracts [21]. Resuscitative efforts continued in the emergency department with the adequate fluid administration. A urine output of at least 1.5 ml/kg/hr was maintained. All the circuits may produce myonecrosis with myoglobinemia, and their attendant complications.

In conclusion, the awareness towards the functional and aesthetic disabling effect of the electrical burns, despite careful treatment, highlights the very important task of the prevention towards this accident. Also, it is required the perfection of tissue sparing surgical techniques that are endangered from the secondary necrosis, to minimise the tissue damages and prevent the late complications. Electrical injuries can be avoided if correct preventive measures are put in place. Work involving contact with electricity should be planned very well to ensure that anyone required to handle the various tasks has the competence to do them. Safety should be encouraged at all times and in all places from the home to the workplace. Education and compliance with safety measures, as well as common sense and respect for the potential danger of electricity, are still essential for avoiding these injuries.

References

1. Electrical Injuries in Emergency Medicine at eMedicine, March 2017.

2. Burn Incidence and Treatment in the United States: (2013) Fact Sheet.: American Burn Association National Burn Repository,2013. Available from: http://www.ameriburn.org/resources_factsheet.php.

3. Electrocution Burns. Burn Survivor Resource Center, (2011). n.p. n.d. Web. September

4. Vierhapper MF, Lumenta DB, Beck H, Keck M, Kamolz LP, Frey M. Electrical injury: a long-term analysis with a review of regional differences. Ann Plast Surg. 2011; 66:43–6. https://doi.org/10.1097/SAP.0b013e3181f3e60f PMid:21102303

5. Sahin I, Ozturk S, Alhan D, Acikel C, Isik S. Cost analysis of acute burn patients treated in a burn centre: the Gulhane experience. Ann Burns Fire Disasters. 2011; 24(1):9–13. PMid:21991233 PMCid:PMC3187939

6. Buja Z, Arifi H, Hoxha E. Electrical Burn Injuries. An Eight-year Review. Ann Burns Fire Disasters. 2010; 23(1):4–7. PMid:21991188 PMCid:PMC3188243

7. Patil SB, Khare NA, Jaiswal S, Jain A, Chitranshi A, Math M. Changing patterns in electrical burn injuries in a developing country: should prevention programs focus on the rural population? J Burn Care Res. 2010; 31(6):931–4. https://doi.org/10.1097/BCR.0b013e3181f93924 PMid:20852430

8. Nursal TZ, Yildirim S, Tarim A, Caliskan K, Ezer A, Noyan T. Burns in southern Turkey: electrical burns remain a major problem. J Burn Care Rehabil. 2003; 24(5):309–14. https://doi.org/10.1097/01.BCR.0000085876.28504.EE PMid:14501400

9. Saracoglu A, Kuzucuoglu T, Yakupoglu S, et al. Prognostic factors in electrical burns: a review of 101 patients. Burns. 2014; 40:702–7. https://doi.org/10.1016/j.burns.2013.08.023 PMid:24054987

10. Sun CF, Lv XX, Li YJ, Li WZ, Jiang L, Li J, et al. Epidemiological studies of electrical injuries in Shaanxi province of China: a retrospective report of 383 cases. Burns. 2012; 38(4):568–72. https://doi.org/10.1016/j.burns.2011.10.012 PMid:22103989

11. Queiroz LF, et al. Epidemiology and outcome analysis of burn patients admitted to an intensive care unit in a university hospital. Burns. 2016; 42:655–662 https://doi.org/10.1016/j.burns.2015.08.002 PMid:26762620

12. Brown M, Chung KC. Postburn Contractures of the Hand. Hand Clinics. 2017; 33(2):317-331. https://doi.org/10.1016/j.hcl.2016.12.005 PMid:28363298

13. Arnoldo B, Klein M, Gibran NS. Practice guidelines for the management of electrical injuries. J Burn Care Res. 2006; 27:439. https://doi.org/10.1097/01.BCR.0000226250.26567.4C PMid:16819345

14. Tambuscio A, Governa M, Caputo G, Barisoni D. Deep burn of the hands: Early surgical treatment avoids the need for late revisions? Burns. 2006; 32:1000. https://doi.org/10.1016/j.burns.2006.02.011 PMid:16949210

15. Mohammadi AA, Bakhshaeekia AR, Marzban S, et al. Early excision and skin grafting versus delayed skin grafting in deep hand burns (a randomised clinical controlled trial). Burns. 2011; 37:36. https://doi.org/10.1016/j.burns.2010.02.005 PMid:20537468

16. Wheeless, CR. Compartment syndromes of the hand and forearm. In: Wheeless' Textbook of Orthopaedics, 2017. www.wheelessonline.com/

17. van der Vlies CH, de Waard S, Hop J, et al. Indications and Predictors for Reconstructive Surgery After Hand Burns. J Hand Surg Am. 2017; 42:351. https://doi.org/10.1016/j.jhsa.2017.02.006 PMid:28359638

18. Moore ML, Dewey WS, Richard RL. Rehabilitation of the burned hand. Hand Clin. 2009; 25:529. https://doi.org/10.1016/j.hcl.2009.06.005 PMid:19801125

19. Kowalske K. Outcome assessment after hand burns. Hand Clin. 2009; 25:557. https://doi.org/10.1016/j.hcl.2009.06.003 PMid:19801128

20. Foris LA, Huecker MR. Electrical Injuries. In: StatPearls [Internet]. Treasure Island (FL): Stat Pearls Publishing; Jan, 2018.

21. Electrical injury. (Updated August 26, 2013) EBSCO Dyna Med Plus website, 2013. Available at: http://www.dynamed.com/topics/dmp~AN~T116526/Electrical-injury.