RFP Indian Journal of Hospital Infection
Volume 5 Number 2, July-December 2023

Management of Electrical Burns in a Tertiary Care Hospital Our Experience

Dharmaseelan[1], Ravi Kumar Chittoria[2], Barath Kumar Singh P.[3]

How to cite this article:
Dharmaseelan, Ravi Kumar Chittoria, Barath Kumar Singh P./Management of Electrical Burns in a Tertiary Care Hospital Our Experience/RFP Ind. Jr. Hosp. Inf./ 2023,5 (2):63–68.

Abstract

Electrical burns can be caused by low-voltage current (usually 220 or 360 V), high-voltage (more than 1000 V) current even by lightning. Electrical injuries and clinical manifestations can vary a lot and range from mild complaints not demanding serious medical help to life-threatening conditions. The primary cause of death in victims of lightning strike or other electrical trauma is cardiac or respiratory arrest. That is why appropriate urgent help is essential. Subsequently electrical burns, deep tissue and organ damage caused by electricity, secondary systemic disorders often demand intensive care and prompt, usually later multistage surgical treatment. In this case report, we discuss the management of electrical burn wounds in our centre.

Keywords: Adult; Electrical; Burn; Management.

INTRODUCTION

Electrical burns are potentially devastating form of multisystem injury with high morbidity and mortality. Most electrical injuries in adults occur in the work place, whereas children are exposed primarily at home. In nature, electrical injury occurs due to lightning, which also carries the highest mortality.[1] The severity of the injury depends on the intensity of the electrical current (determined by the voltage of the source and the resistance of the victim), the pathway it follows through the victim's body, and the duration of the contact with the source of the current.[1,2] Immediate death may occur either from current induced ventricular fibrillation or asystole or from respiratory arrest secondary to paralysis of the central respiratory control system or due to paralysis of the respiratory muscles. Presence of severe burns (common in high voltage electrical injury), myocardial necrosis, the level of central nervous system injury, and the secondary multiple organ failure determine the subsequent morbidity and long-term prognosis. In this case report, we discuss the management of high voltage electrical burns in our centre.

MATERIALS AND METHODS

This study was done at tertiary care hospital after obtaining approval of departmental scientific and ethical committee. Informed consent was obtained from the patient. This is a prospective descriptive

Author Affiliation: [1]Junior Resident, Department of Plastic Surgery, [2]Professor, Head of IT Wing and Telemedicine, Department of Plastic Surgery & Telemedicine, [3]Senior Resident, Department of Plastic Surgery, Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry 605006, India.

Correspondence Author: Ravi Kumar Chittoria, Professor, Head of IT Wing and Telemedicine, Department of Plastic Surgery & Telemedicine, Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry 605006, India.

E-mail: drchittoria@yahoo.com

Received on: 09.11.2023

Accepted on: 15.12.2023

non randomised case study about a 27 year old male sustained electrical burn injuries while he was working near the electric post for party decoration work. He sustained electrocution by contact with electrical line. He arrived to our emergency department with an electrical burn in both hands, abdomen, left thigh and both feet (fig. 1). It was

Fig. 1: At time of Admission

presumed that the current entered his Right hand and exited through his left foot. At the time of admission his Glasgow Coma Scale score was 15. Multiple second degree superficial burns involving anterior aspect of left lateral abdomen region, bilateral thighs (anterior aspect), and at left ankle region. The serum electrolytes, urea and creatinine, urine analysis, and electrocardiogram were normal, urine myoglobin negative. He was resuscitated with the standard WHO burn protocol. Patient was asymptomatic with no seizures, syncope, focal neurological deficits. Initially, serum myoglobin values rise up to 30000 IU/l after three days. The patient was hydrated adequately as per WHO protocol in electrical burns. The urine myoglobin was negative during the hospital stay. The serum myoglobin values came back to normal after one week. The electrical burn will undergo progressive skin necrosis, so the debridement was done after demarcation of necrotic patch. The dermabrasion is done using the mechanical dermabrader. The non-viable necrotic tissue was debrided without damaging the normal tissues in both horizontal and vertical planes with dermabrader. After wound debridement, derma-abrasion was done till the removal of unhealthy tissues. Then patient undergone split thickness skin graft (fig. 2). After

Fig. 2: Dermabrader Assisted Tangenital Excision and Skin Grafting

wound debridement we have used regenerative therapies like Low level laser therapy, Autologous platelet rich plasma, collagen scaffold dressing. Post procedure patient need closed dressing system like NPWT (negative pressure wound therapy) for improving wound healing and for preventing infection. Patient undergone multiple sessions of wound debridement with other regenerative techniques autologous platelet rich plasma (fig. 3), low level laser therapy (LLLT), collagen scaffolding (fig. 4) and Negative pressure wound therapy (fig. 5). The raw area over the palmar aspect of hand was grafted with split thickness skin graft (fig. 6). Once the burn wounds healed well, we have started scar management with Low Level laser therapy (fig.

Fig. 3: Autologous Platelet Rich Plasma Injection

Fig. 4: Collagen application

Fig. 5: Regulated oxygen Negative Pressure Wound Therapy

7), silicone gel (fig. 8), aloe vera gel (fig. 9), Onion extract application (fig. 10) over the healed burn

Fig. 6: Remnant raw area over entry site treated with skin graft

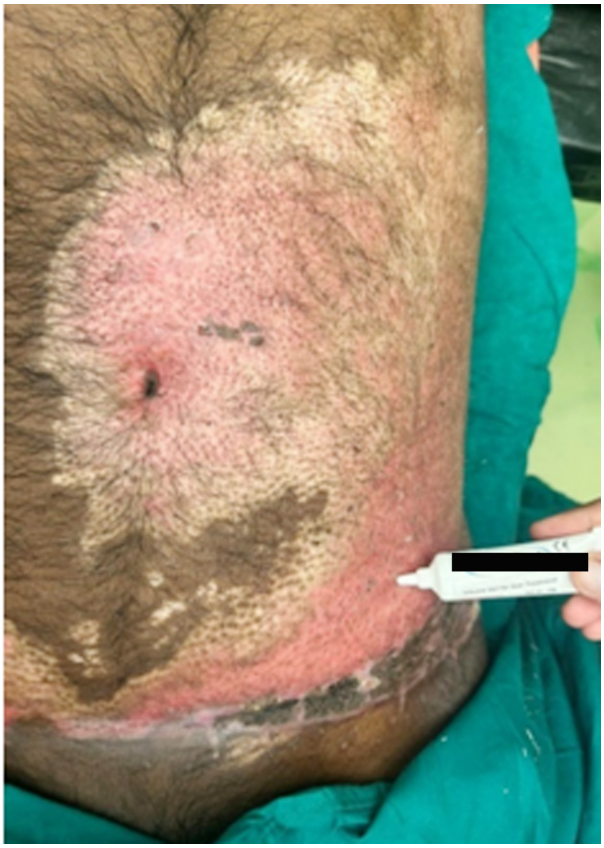

Fig. 7: Lysil gel application

Fig. 8: Low level laser therapy for healed donor site and burnt site

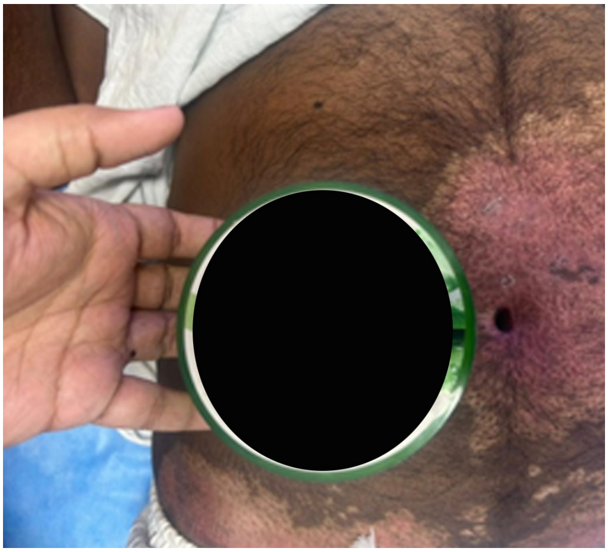

Fig. 9: Aloevera gel application

wounds to prevent the abnormal scarring. Pressure garment therapy was applied over the healed burn wounds (fig. 11).

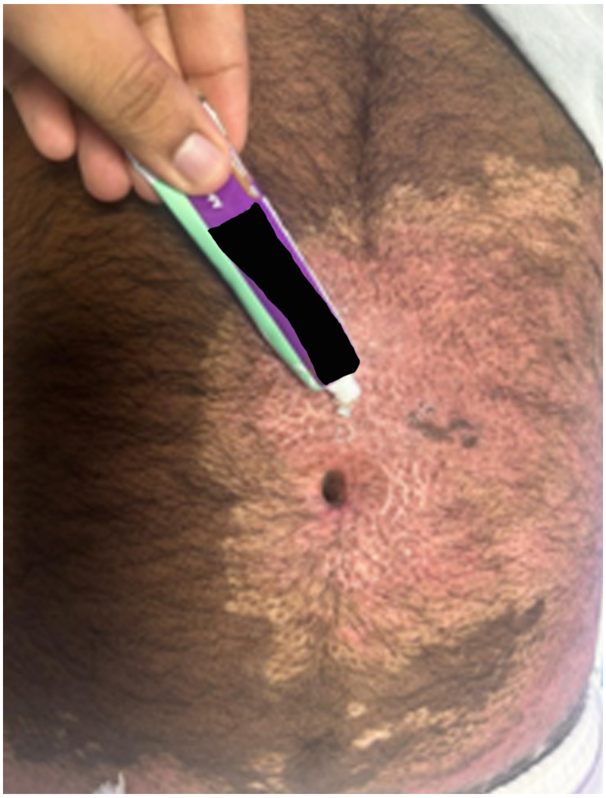

Fig. 10: Onion Extract Application

RESULTS

Patient was compliance with all the above techniques we have used for regeneration of the burn wounds. No complications were noted post

Fig. 11: Pressure Garment Application

procedure. There was no complication associated with the skin graft applied. The skin graft was healthy without any necrosis after 2 weeks (fig. 12). Patient discharged successfully.

Fig. 12: At Discharge

DISCUSSION

Electrical injuries occur when a conductor or electrical source sends high-energy current through the body. Current flow, arc flash, or burning clothing cause injuries. The former two cause thermal burns by converting electricity to heat. Internal tissues or organs may be much more badly damaged than the skin, therefore the outward appearance of an electrical burn may not correctly reflect the harm. Electrical injuries in children are mostly home, while in adults they are mostly occupational. Electricity injures men more than women. Hands are the main source, then head. Feet are normally ground level. Current is directly proportional to voltage and inversely proportional to resistance, according to Ohm's Law. All three contribute to electricity burn pathophysiology. Low-frequency alternating current (AC) used in homes causes extensive injuries because it causes local muscle contraction (flexor muscles greater than extensor muscles) at the site of contact with the electrical source, often preventing the victim from releasing the offending object. DC contracts one strong muscle, typically throwing its victim away from the energy source. High skin resistance causes diffuse burns. Lower skin resistance causes deeper, organ involving burns. Electricity flows through highly resistant skin tissue and subsequently through less resistant tissues, whether skin is dry or moist. When internal tissues and organs are badly destroyed, skin burns may appear moderate.[3]

Patients with electrical burns that look like thermal burns should be examined head-to-toe, including the source of electrical injury, the voltage and current type (AC or DC) of the energy source, the duration of electrical exposure, and how the injury was caused, and treated according to trauma patient treatment protocols with priority to ABCDEs with a primary and secondary survey. Patients exposed to high voltage should have continuous cardiac monitoring during examination. If the patient has altered mental status or head trauma from a fall or blast, CT imaging may be considered.

After resuscitation, superficial and profound burn patients are cleansed, gently gauze debrided, and covered with topical antibacterial agents and dressings before surgery. Tangential wound excision involves thinly removing eschar to access healthy tissue. Punctate wound bed haemorrhage indicates viable tissue and excision.[4] Tangential excision can be used on any skin eschar to retain viable tissue and reduce tissue removal. Early burn excision and grafting are necessary for successful burn therapy due to infection control. Tangential excision can be performed alone or with various methods to obtain an allograft depth. Split-thickness skin grafting continues to be the most common permanent burn wound closure procedure because it restores epidermal function, reduces hypothermia, protein and fluid losses, and infection.[4]

Negative Pressure Wound Therapy (NPWT) removes exudates and infections and contracts the wound margin. NPWT is safe and effective for post-debridement wounds. NPWT began, and wound size was measured at dressing change. Platelets regulate inflammation, angiogenesis, cell migration, and proliferation by releasing growth factors and anti-inflammatory cytokines, which may speed wound healing.[5,6]

Autologous platelet rich plasma (APRP) contains growth factors that cause intracellular cell proliferation and wound healing when injected or sprayed. Aloe vera's anti-inflammatory, immunological, antibacterial, antiviral, and histamine lowering properties speed burn wound healing.[9] The recent review study found that Aloe vera is universally considered the best wound dressing. Silicone gel raises hypertrophic burn scars' skin surface temperature by 1.7°C, which can promote collagenase activity and scarring.[7] Silicone based scar treatment solutions may increase skin surface temperature. Static electric fields may be involved in scar involution and collagen realignment due to the negative static electric field produced by Silicone gel and skin friction. If MMP-1 activity is uneven between ECM syntheses during wound healing, excessive extracellular matrix accumulation may cause a hypertrophic scar or keloid. Both pathologies may involve excessive type I collagen buildup, decreased MMP-1 activity, and high TIMP-1 expression. Several studies show that onion extract suppresses fibroblast development. Fibroblast inhibition and antiproliferation are associated with onion extract. MMP upregulation by onion extracts modifies ECM.[10,11] Low Level Laser Therapy (LLLT) can cause photochemical reactions in tissue and cells, known as biological stimulation or photobiological regulation. Previous study has shown that LLLT alters mitochondrial photo receptors, accelerates the electron transport chain of generated energy, increases mitochondrial respiration, and increases ATP production. Thus, LLLT can alter cellular redox status and activate signalling pathways that drive transcription factors implicated in proliferation, tissue repair, and regeneration.[12] Compression reduces hypertrophic scars in 60–85% of patients. Scars did not form in incisional wounds compressed in the opposite direction to wound tension. These findings imply that mechanical scar forces may reduce fibroblast differentiation to myofibroblasts, limiting scar contraction and collagen deposition. The current study's reduced scar contraction may have been due to reducing scar strain, which reduces myofibroblast differentiation and collagen deposition.[13-15]

CONCLUSION

The application of regenerative medicine therapies in the treatment of complex reconstruction in electrical burns has significantly aided in improving reconstructive outcomes. There construction ladder is continuing to evolve and may become the standard of care for effective management of composite tissue wounds. This has to be applied to the multiple number of cases for the assessment of the hybrid reconstructive ladder.

Conflicts of Interest: None

Authors' Contributions: All authors made contributions to the research, is putatively expected to be useful article.

Availability of Data and Materials: Not applicable.

Financial Support and Sponsorship: None.

Consent for Publication: Not applicable.

REFERENCES

1. Gentges J, Schieche C. Electrical injuries in the emergency department: an evidence-based review. Emerg Med Pract. 2018 Nov;20(11):1-20.
2. Brandão C, Vaz M, Brito IM, Ferreira B, Meireles R, Ramos S, Cabral L. Electrical burns: a retrospective analysis over a 10-year period. Ann Burns Fire Disasters. 2017 Dec 31;30(4):268-271.
3. Gentges J, Schieche C, Nusbaum J, Gupta N. Points & Pearls: Electrical injuries in the emergency department: an evidence-based review. Emerg Med Pract. 2018 Nov 01;20(Suppl 11):1-2.
4. Mathes SJ, Nahai F. Reconstructive Surgery: Principles, Anatomy & Technique. Vol. 2. New York: Churchill Livingstone; St. Louis: Quality Medical; 1997.
5. Shpichka A, Butnaru D, Bezrukov EA, Sukhanov RB, Atala A, Burdukovskii V, Zhang Y, Timashev P. Skin tissue regeneration for burn injury. Stem cell research & therapy. 2019 Dec; 10:1-6.
6. Dumville JC, Munson C, Christie J. Negative pressure wound therapy for partial thickness burns. Cochrane Database of Systematic Reviews. 2014(12).
7. Mustoe TA. Evolution of silicone therapy and mechanism of action in scar management. Aesthetic plastic surgery. 2008 Jan;32: 82-92.
8. Moghbel, A., Ghalambor, A., Allipanah, S. Wound Healing and Toxicity Evaluation of Aloe vera Cream on Out patients with Second Degree Burns. Iranian Journal of Pharmaceutical Sciences, 2007; 3(3): 157-160.
9. Duansak, D., Somboonwong, J., and Patumraj, S. 'Effects of Aloe Vera on Leukocyte Adhesion and TNF α and IL 6 Levels in Burn Wounded Rats'. 1 Jan. 2003: 239 – 246.
10. Jackson, B. A., & Shelton, A. J. (1999). Pilot Study Evaluating Topical Onion Extract as Treatment for Postsurgical Scars. Dermatologic Surgery, 25(4), 267–269.
11. Campanati, A., Savelli, A., Sandroni, L., Marconi, B., Giuliano, A., Giuliodori, K., Ganzetti & Offidani, A. Effect of Allium Cepa- Allantoin- Pentaglycan Gel on Skin Hypertrophic Scars: Clinical and Video-Capillaroscopic Results of an Open-Label, Controlled, Nonrandomized Clinical Trial. Dermatologic Surgery, 2010,36(9), 1439–1444.
12. Lu W, Lu K, Peng Y, Chen P, Bian W, Yu W. The efficacy of low-level laser therapy for the healing of second-degree burn wounds on lower limbs of glucocorticoid-dependent patients. Lasers in Medical Science. 2023 Aug 15;38(1):186.
13. Monstrey S, Middelkoop E, Vranckx JJ, Bassetto F, Ziegler UE, Meaume S, Téot L. Updated scar management practical guidelines: non-invasive and invasive measures. J Plast Reconstr Aesthet Surg. 2014 Aug;67(8):1017-25.
14. Friedstat JS, Hultman CS: Hypertrophic scar management: What does the evidence show? A systematic review of randomized control trials. J Burn Care Res, 34: 2, 2013.
15. Bloemen MC, van der Veer WM, Ulrich MM *et al.:* Prevention and curative management of hypertrophic scar formation. Burns, 35: 463-75, 2009.