Assessment of the Thanatological Aspects of Electrical Injuries

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ARTICLE INFO

Keywords:
Electrocution injury
Electric exposure
Muscle contraction
Tissue damage

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The author has reviewed and approved the final version of the manuscript.

https://doi.org/10.59345/sjfm.v1i2.63

ABSTRACT

Instances of electrocution are commonly encountered, although most of them may be prevented. The purpose of this review was to elucidate the thanatological features of electrical damage. Alternating current (AC) is an electrical current that periodically reverses its direction in a sinusoidal pattern and has the ability to cause muscular tetany, which can occur with extended exposure to the current. High-voltage alternating current (AC) above 1000 V frequently leads to electrical injuries in occupational environments. These injuries are marked by significant tissue damage and a heightened risk of sickness and mortality. Direct current (DC) is the continuous and unbroken movement of electric charge in a singular direction. Instances of direct current (DC) include phenomena such as lightning, batteries, and vehicle electrical systems. This is more likely to lead to severe isolated muscle spasms and asystole. The impact of AC on the body is mostly determined by its frequency. Tetany, a condition marked by persistent muscle contraction, is often induced by low-frequency alternating current (AC). This can be a challenge for an affected individual to detach from the current source, leading to a prolonged period of exposure. In conclusion, the extent of damage resulting from electric shock is determined by the attributes, intensity, duration, and pathway of the electrical current. Dermatological findings can be misleading and may not provide an accurate assessment of the extent of injury to underlying tissues.

1. Introduction

Electrocution incidents are frequently encountered, although the majority of them may be avoided. Exposure to low-voltage or high-voltage electric current or a lightning strike both result in this damage.1,2 The electric current can be classified into two types: alternating current (AC) and direct current (DC). Its magnitude is quantified in units of volts (V). Electricity induces immediate harm by direct tissue destruction, muscular tetany, direct heat injury, coagulation necrosis, and associated trauma. Several things affect how bad an electrical injury is: voltage, current type, tissue resistance, humidity, route, duration of exposure, other injuries happening at the same time, and comorbidities. The magnitude of the current is the primary factor that determines the extent of tissue damage. Electric current flows through the tissue with the least resistance, converting it into energy and producing heat, resulting in direct thermal damage. The electrical conductivity of tissues varies across the body, with nerve cells being the most susceptible and bones being the most resilient to electrical current.3–5 This review aimed to describe the thanatological aspects of electrical injuries.

Types of injuries resulting from electric shock

Alternating current (AC) is an electrical current that cyclically changes direction in a sinusoidal waveform...
and has the potential to induce muscular tetany, resulting in prolonged exposure to the current. AC can have either a low voltage or a high voltage. The majority of households and companies utilize alternating current (AC) at a low voltage level, often below 1000 volts. Electrical injuries caused by low voltage can vary in severity, ranging from minimal harm to substantial damage and even fatality. Electrical injuries caused by high-voltage alternating current (AC) (exceeding 1000 V) commonly occur in work settings and are characterized by severe tissue damage and increased rates of illness and death.

Direct current (DC) refers to the steady and uninterrupted flow of electric charge in a single direction. Examples of DC include lightning, batteries, and automotive electrical systems. This is more likely to result in severe isolated muscular spasms and asystole. Lightning distinguishes itself from other high-voltage electric shocks by rapidly delivering a direct current of millions of volts within a very short time frame.6–8

There are three forms of electrical burns: flash burns, flame burns (clothing), and burns caused by the direct burning of tissue by electric current. There is no correlation between the extent of the injury and skin damage. While it is true that not all electrical injuries result in skin damage, it is possible for even large, deep wounds to cause minimal harm to the skin. The symptoms and indications might vary from extremely modest to life-threatening. The existence of both entering and outbound burns signifies an escalated susceptibility to profound tissue harm.

Electric current flowing through skeletal muscle can lead to muscle necrosis and contraction of such intensity that it can induce bone fractures. Immediate death can result from ventricular fibrillation, asystole, or apnea if the current goes through the heart or brain stem. Electrical burns are a relatively underappreciated yet highly severe type of burn that can lead to extensive and major consequences.6–9

When an electrical injury occurs, it is important to have a strong suspicion for significant deep tissue necrosis. The outermost layer of the skin may seem harmless, leading to a delay or complete failure in identifying a deep tissue injury. Deep tissue necrosis causes edema to get very bad in the tissues below, which makes getting compartment syndrome much more likely.7

**Clinical sign of electrocuting incidence**

The majority of individuals possess the ability to detect electrical energy through tactile sensation at a current of 1 milliampere (mA). Let-go current is the level of current (measured in amps) at which a person may still let go of the source, even when muscle contractions are caused. The tolerance for amperage per individual, known as let-go current, varies based on their physical attributes, such as muscle mass and weight. A typical male weighing 70 kg, for instance, may experience a let-go current of around 75 mA for direct current (DC) and 15 mA for alternating current (AC). The majority of children can withstand a let-go current of 3 to 5 mA, which is significantly less than the current that most circuit breakers produce. An electrical switch is specifically engineered to disrupt the flow of electricity in the event of an excessive amount of electrical current detected within a household.8–10

The frequency of AC primarily determines its effect on the body. Low-frequency alternating current (AC) has a tendency to induce tetany, which is characterized by prolonged muscle contraction. This can make it challenging for an afflicted person to disconnect from the current source, resulting in a longer duration of exposure. Due to this rationale, low-frequency AC can frequently pose a greater risk than high-frequency AC. Typically, AC is roughly three to five times more detrimental than DC, with the same voltage and current. Furthermore, direct current (DC) typically induces a solitary convulsion or contraction, which commonly results in the individual being propelled away from the electrical source.11–13

Ultimately, the assessment of tissue damage necessitates consideration of electrical field intensity. The determination of field strength relies on the magnitude of voltage encountered and the extent of contact with the surrounding region. For instance, when a significantly high voltage is applied to a larger surface area, the resulting field strength may be equivalent to or potentially lower than that of a much
smaller voltage applied to a much smaller surface area. Hence, low-voltage injuries, despite being spread out over a smaller region, can frequently cause equivalent damage to high-voltage injuries, which are spread out over a wider area.\textsuperscript{9,14}

Low electrical field strength is correlated with an instantaneous, shock sensation that does not cause any substantial harm. On the other hand, a strong electrical field can hurt the tissues by either electrochemically or thermally, which can cause protein coagulation, coagulation necrosis, hemolysis, thrombosis, muscle or tendon avulsion, or dehydration. A high electrical field strength injury can lead to a lot of tissue edema. This can be caused by thrombosis, vascular congestion, or damaged muscles swell up. This can potentially lead to compartment syndrome in addition to the initial electrical injury. Tissue edema can lead to dehydration, along with hypovolemia and hypotension. Severe muscle injuries can result in rhabdomyolysis, myoglobinuria, and other disruptions in electrolyte balance. Collectively, these consequences expose patients to a significantly elevated risk of acute renal damage.\textsuperscript{12,14}

**Organ complication of electrical injury**

Cardiopulmonary or respiratory arrest, dysrhythmia, neurological dysfunction (manifesting as autonomic dysfunction with fixed, dilated, or asymmetric pupils), paralysis, vascular injury, tissue edema and necrosis, compartment syndrome, associated traumatic injuries (such as a ruptured eardrum or fractured rib), pneumothorax, rhabdomyolysis, acute kidney injury, hypovolemia, infection, ocular complications, sepsis, and gangrene are among the potential complications.\textsuperscript{13-15}

2. Conclusion

The severity of harm caused by electric shock is governed by the characteristics, magnitude, duration, and route of the electric current. Dermatological observations can be deceptive and may not accurately reflect the severity of underlying tissue damage.

3. References

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