Fatal Burns Due To Arcing Current

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Abstract

Electrical injuries are potentially devastating lesions with high morbidity and mortality, which can be prevented by using simple safety measures. These injuries can occur in various ways like direct contact with electrical source, arcing of electricity to a victim at ground potential, flash burns and flame burns.

They may be associated with low-voltage and high voltage circuits. The severity of the injury mainly depends on the amount of current flow, voltage, and resistance of the body. In high voltage electrocution the current can jump through the air when the body approaches the electric source, closing the circuit, which is known as "arcing".

In present case, the deceased sustained accidental burn injuries from an arcing generated around electric post due to breakage of insulation. The case was charged under 337 and 304 (A) IPC against the State Electricity Board. An attempt is made to discuss about electrocution, arcing injuries and related legal issues.

Keywords: Electrical injuries, Arcing, High voltage current, Electrocution

Introduction

Electrical injuries are potentially devastating lesions with high morbidity and mortality. They are associated with low-voltage or high voltage circuits. Majority of them are accidental in nature and work-related. Electric circuits with 1000 V or more are usually classified as high voltage and those with less than 1000 V as low voltage [1, 2]. In high voltage accidents, it is known that direct contact is not necessary. The current can jump through the air when the body approaches the electric source, closing the circuit which is known as "**arcing**" [3]. An arc is a flow of electrons through a gas such as air to a victim at ground potential supplying an alternative path to the ground[4]. It occurs when two surfaces approach each other, before the two halves of the interface actually touch. Arc injury occurs when the victim becomes the part of arc itself [5].

In this case the victim accidentally entered the arcing zone of an electric post sustaining the burn injuries which led to his death. The insulation between high tension wire and electric post was broken and after repeated complaints it was not replaced. Hence the state electricity board was booked under negligence suit.

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Case Report

History

Deceased accidentally sustained burn injuries from an arcing current generated around a high voltage electric post while working in the field **(Fig.1).** He became unconscious and was taken to the hospital and succumbed while on treatment after a few weeks.

The victim has complained the electricity board regarding the replacement of the broken porcelain cup, insulation between the high tension electric wire and the post. But the insulation was not replaced. Hence the case was charged for negligent suit under Indian Penal Code sections 337 (Causing hurt by act endangering life or personal safety of others) & 304A (Causing death by negligence) against the State Electricity Board.

Autopsy

Findings over the body

Varying degrees of superficial to deep burn injuries were present over the body involving the lower limbs, right & left upper limbs and front of the chest (Fig. **2).** The total body surface area burnt was 35%. The injuries were exposing the underlying muscles and bones in the lower limbs and covered with yellowish- green slough at places (Fig. 3).

Cause of death

Complications of thermal burn injuries sustained as a result of arcing current.

Discussion:

Electrical injuries consist of four main types which are electrocution (fatal), electric shock, burns and falls as a result of contact with electrical energy[4]. Most of the electrical injuries are accidental in nature. The severity of the electrical injury mainly depends on the amount of current flow, voltage and resistance of the body. Tissues that have a higher resistance to electricity, such as skin, bone, and fat, tend to sustain more injuries and tissues that have low resistance like nerves and blood vessels conduct electricity readily sustain less demonstrable injuries [5].

Electric circuits with 1000 V or more are usually classified as high voltage and those with less than 1000 V as low voltage [6]. But in our state, circuits with 650 V or less are called low voltage and circuits with more than 650 V are called high voltage [5]. High-voltage injuries can be grouped into "**true high-tension injuries**," which are caused by an electrical contact, and "burns" because of **flash** and **ignition of clothes [7].**

Joule heating and **Electroporation** are the mechanisms of cell injury in long contact and brief contact respectively [8].

Flash burns occur when there has been an arc of current from a high-tension voltage source. The heat produced by this arc can cause superficial burns to exposed parts of the body. Arc injury occurs when the victim becomes **part of the arc itself** It produces intense heat, and fatal lesions can occur even when the victim is several feet away from the arc. The distance of the arc [9] is proportional to the voltage as shown in Table No. 1. Because of heat, the superficial tissue may shrivel out or tear, giving appearance of an abrasion or a laceration. Circumscribed burns occur in the portions where the arc contacts the victim's body surface giving rise to a "**crocodile skin**" appearance.[10]

In our case the deceased sustained injuries from flash burns when he accidentally entered the arcing zone. John Lane [11], in his article on " Arc – Flash hazard analysis' mentions about flash protection boundary around high tension electric source where in the initiation of arc occurs. He divided the arcing zone into following categories: area next to the source is prohibited approach, and then restricted, then limited the last one is flash protection boundary as shown in Fig. No.3.

Table 1: The distance electric arc can jump [9]

Voltage	Distance electric arc can jump
1,000	Few cm
5,000	1 cm
20,000	6 cm
40,000	13 cm
1,00,000	35 cm

Conclusion

Arcing current injuries are almost always accidental and fatal. In our case death was due to complications of thermal burn injuries sustained due to an arcing current. Arcing current fatality is **hard to predict** and prevent because of its **apparent suddenness**. Arc flash is a hazard from electric shock which must be guarded against while performing work associated with live equipments[12] .Arc flash labels for high voltage receptacles should be put in appropriate places. **Public awareness** of this issue, **Correct labelling** of high voltage receptacles, good quality **safety shoes**and **proper earthing** of the high voltage posts can reduce electrical injury cases.

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Fig. 1: High voltage electric post in the field

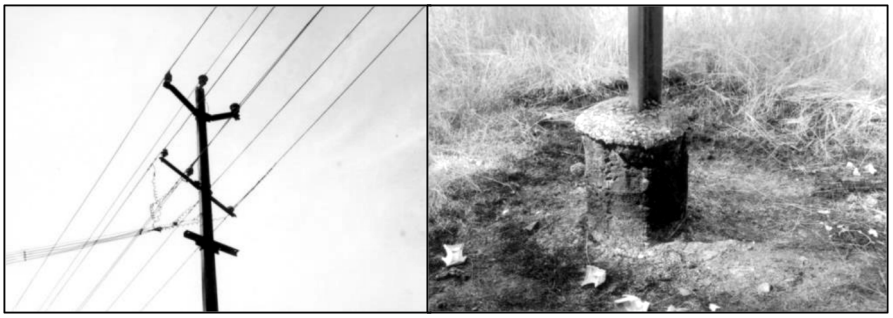

Fig. 2: Burn injuries present over the body

Fig. 3: Injuries covered with yellowish- green slough lower limbs