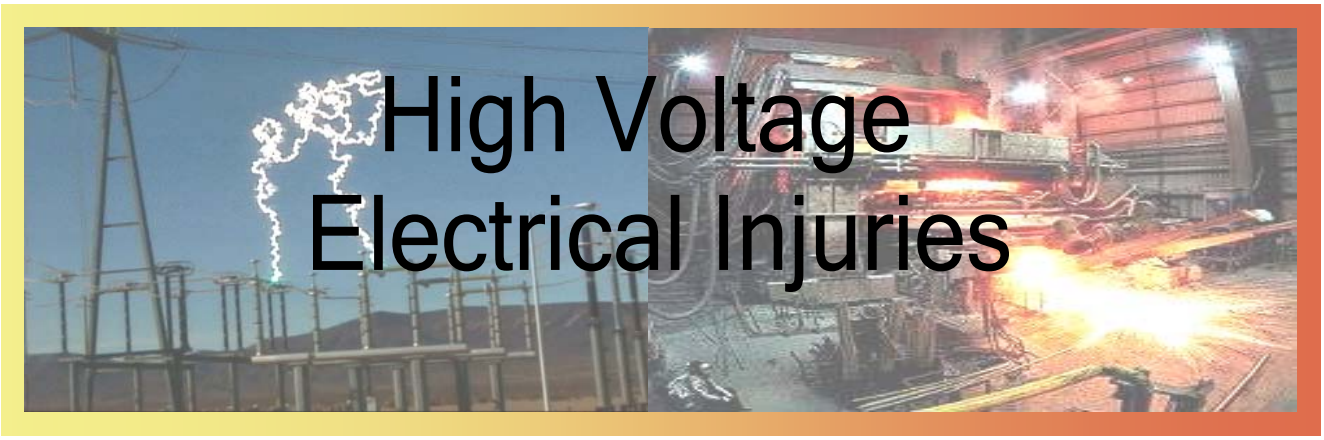


High Voltage Electrical Injuries

Overview

A High Voltage Electrical Injury is defined as an injury in which a person comes in contact with an electrical current equal to or exceeding 1,000 VOLTS.

An electrical source less than this amount is not considered to be capable of causing the tissue damage characteristic of this type of electrical injury. However death can certainly occur with a Low Voltage Source, e.g. Cardiac Arrest.

An electrical current will produce an array of injuries if the current passes through the body. Most of the damage is beneath the skin surface and therefore the actual injury can easily be underestimated.

COMPONENTS OF INJURY

There are often several possible components to the injury. The electricity itself damages tissues especially muscles and nerves. The majority of the damage is beneath the skin leading to a "hidden" injury.

Terminology

Voltage: is the potential electrical force generated by the source

Amperage: is the actual amount of current passing per unit time

Resistance Volts/Amps

Current: Amount of amps going thru the victim

Heat: Production is proportional to resistance flow of current

Voltage Source:

- Household current ie. plugs, outlets etc. (110-220 VOLTS)
- Current in residential areas is < 5,000 VOLTS
- High tension poles along the highway (50,000 – 100,000 VOLTS)

Terminology can be a bit confusing when discussing Electricity. Voltage refers to the potential power of the source. Amperage refers to how much electricity is actually being delivered once a connection (victim) is made. Resistance is the difficulty the current has in passing and is usually demonstrated as local heat (burn) production. The only measurable number in an electrical injury is the voltage of the source.

Components of Injuries

- passage of the current itself ("current of injury")
- skin burn from an "arc" or flash burn
- Skin burn with clothes on fire
- blunt trauma from fall, explosion

High Voltage Electrical Injury

The **first component** is the injury caused by the electrical current itself. Electricity itself leads to tissue injury, the mechanism of which is not well understood. The electric current, entering the body, follows along the path of least resistance, along water which means damage to muscle, nerves and blood.

Temperature of a thousand degrees can develop along the path. Massive muscle damage can occur leading to an amputation rate of up to 40%.

The pathway of current can be somewhat unpredictable, but, in general, current passes from a point of entry through the body to a grounded site, a site of lower resistance to flow compared with air, which is a poor conductor. Extremely high voltage sources usually exit in multiple areas in an explosive fashion.
The resistance of dry skin is high, resulting in severe local injury, at the entrance site.

A wet hand will allow passage of current with little resistance and the entrance site may look quite benign while the damage by the current may be severe.

Current passing from hand to hand or hand to thorax has a high risk of producing cardiac fibrillation compared to hand to foot passage. Passage through the head is likely to cause an initial respiratory arrest and subsequent severe neurologic impairment.

The determination that a high voltage current injury passed thru underlying tissue is the finding of contact point sites also called "entrance and exit sites." Their presence is diagnostic of an electrical injury beneath the skin.

The site where the passing current reaches the surface, contact "exit" site, can often look like holes or small skin ulcers with a depressed center and appear innocuous. However, these wounds are very deep as the current is coming from the inside out, a current has clearly passed thru the body.

The presence of contact (entrance and exit) points indicates the passage of a current. Therefore, the patient must be transferred to a hospital preferably a burn center.

Direct Current Injuries

- Severe muscle, nerve, blood vessel damage
- Cause of limb loss
- Neurological Damage
- Cardiac Arrest

Contact "entrance" site on hand. Note very deep burn area.

More extensive contact Burn on Feet

Contact "exit" site on toes. Tissue has loss from inside out

Cardiac Arrest

The cardiac arrest process is due to both the direct alteration of rhythm by the current, leading to fibrillation or to the depression of respiration and subsequent hypoxia induced arrest.

Hand to hand passage of a high voltage current has a reported immediate mortality of 60%. The initial heart problems are often reversible with CPR.

Muscle Damage

Electrical burns more closely resemble a crush injury than they do a thermal burn. The damage below the skin where the current passes is usually far greater than the appearance of the overlying skin would indicate. The immediate damage to muscle is caused by the heat, which is usually patchy in distribution along the course of the current, often most severe near the bones.

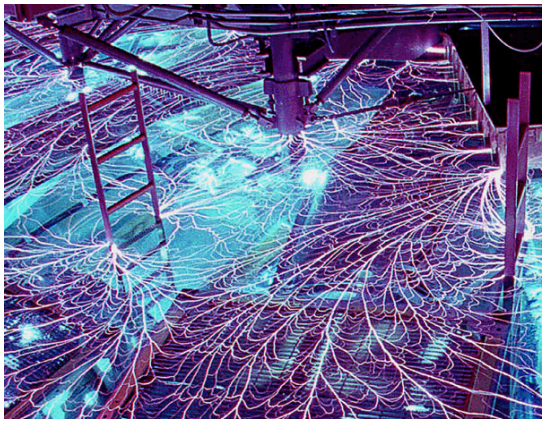
Orthopedic Injury

The most common orthopedic injury occurs as a result of severe immediate muscle spasm, which is capable of producing long bone fractures and dislocation at major joints.

ORTHOPEDIC INJURIES OCCUR AS A RESULT OF THREE PROCESSES:

- **Muscle spasm-induced fractures and dislocations**
- **Heat-induced local bone destruction**
- **Devascularization of bone**

The **second component** is the injury from "arcing" of the electricity from its sources. Ionization of air particles associated with a voltage drop is called arcing. The heat generated can be as high as 4,000°C and can vaporize metal. This process leads to deep "flesh burns," often to exposed areas or areas of the body closest to the arc



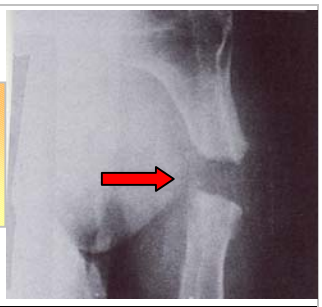
Malfunctioning High voltage electrical equipment at the work place

The **third component** is a skin burn caused by flames. A flash from the power source can cause the ignition of clothing. A flame burn can occur without a current passing through the victim.

Skin burn resulting from electrical burn accident

The **fourth component** is a traumatic injury caused by both intense muscle spasm from the current, from a fall or the explosive force of the electricity.

Humerous fracture caused by a fall



Prevention:

- Organizing public education on risks of contacting sources of electricity
- Focus on Construction workers, painters and individuals working around high structures such as trees- *dangers of hidden high power lines*
- Focus on any handymen or professionals working outdoors on roofs, ladders etc.
- Amateurs working near dangerous hidden high tension
- Focus on dangers of "downed" high tension wires after storms
- Focus on young people in general as to the risks of high voltage electricity
  - *You don't have to touch the wire to get severely injured*

Treatment:

- Scene safety
  - **do not** touch patient until removed from source of electricity
- Stop any burning process
- BLS or ALS as indicated

- BASE NEUROLOGICAL
  - **A-** ALERT, AWAKE, oriented
  - **V**- Only to VERBRAL command
  - **P-** Only to PAINFUL stimulus
  - **U-** UNRESPONSIVE

- Expose, Examine and Transfer
  Look For:
  - contact point sites
  - flash or flame burns

  Other traumatic injuries-
  Transfer according to protocol

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