Protocols of Electrical Burn Injury Management

Essay protocol submitted in fulfillment of the M.Sc Degree in General Surgery

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بسم الله الرحمن الرحيم

"وما أوتيتم من العلم إلا قليلاً"

صدق الله العظيم

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Abstract

(Key words: electrical injury, electrical shock, electrical burns, low-voltage burns, lightning strikes, household electrical burns)

Electrical Injury is a potentially devastating form of multisystem injury with high morbidity and mortality. Electrical injury should be viewed and managed as a multisystem injury, and there is virtually no organ that is protected against it. The resuscitation better done in intensive care unit after proper and careful investigations with special regards to cardiac and respiratory support. Electrical burn management follows the general roles of thermal burn management with its new reconstructive modalities.

Table of Content

List of Abbreviations

- **V : Voltage**
- **A : Amperage**
- **AC : Alternating current**
- **DC : Direct current**
- **ESU : ElectroSurgical Unit (Diathermy)**
- **CPK: creatine phosphokinase**
- **CPR : Cardiopulmonary Resuscitation**
- **EMTs : Emergency Medical Teams**
- **TBSA : Total body surface area**
- **Ω : Symbol for the unit of resistance to the electrical current it called Ohm**
- **LDH : Lactic dehydrogenase**
- **99mTc-PYP scan : Technetium 99 muscle stannous pyrophosphate scan**
- **IV : Intravenous**
- **RL : Ringer lactate**
- **NS : Isotonic sodium chloride solution (Normal Saline)**

Introduction and Aim of work

Introduction

Electrical Injury is a relatively infrequent but potentially devastating form of multisystem injury with high morbidity and mortality. ***(Baker et al: 2002)***

Most electrical injury in adults occurs in work place, whereas children are exposed primarily at home. In nature electrical injury occurs due to lightening, which also carries the highest mortality. ***(Fahmy et al.; 1999)***

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 follow in the victim's body, and the duration of contact with the source of current. ***(Shaw et al.; 1995)***

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 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 system organ failure determines the subsequent morbidity and long term prognosis. ***(Jain et al.; 1999)***

In the United States alone, electrical injuries cause about 2400 admissions to emergency rooms annually, accounting for 3-5 percent of all admissions to major burn centers and resulting in 1500 deaths per year. The number of electrical accidents is steadily increasing. One third of all major electrical accidents occur in electrical workers, one third in construction workers, and the remaining one third in home settings, especially among children. ***(Arnoldo et al.; 2006)***

There is no specific therapy for electrical injury and the management is symptomatic. Although advances in the intensive care unit, and especially in burn care, have improved the outcome, Prevention remains the best way to minimize the prevalence and severity of electrical injury. ***(Baker et al: 2002)***

Aim of Work

The aim of work is to give an account on the pathophysiology of electrical burn injury, factors influencing the sequelae of the injury, the outcome complications and the recent protocols of its proper management.

Review of Literature

Anatomy of the skin

The skin is the primary resistor against the electrical current, with a resistance ranging in adults between 40,000 and 100,000Ω, depending on its thickness as the thicker the skin the higher its resistance. Thus the intensity of the electrical shock produced by certain voltage will vary between victims of different sex and age. ***(Jain et al.; 1999)***

Skin forms the largest organ of the body and accounting for about 16 percent of a person's weight. It performs many vital roles as both a barrier and a regulating influence between the outside world and the controlled environment within our bodies. Internal body temperature (core temperature) is controlled through several processes, including the combined actions of sweat production and the rate of blood flowing through the network of blood vessels within the skin. ***(Taylor et al.; 1998)***

There are two main layers of skin:

- Epidermis
- Dermis.

Epidermis

This is the outermost layer. In most parts of the body the epidermis is about 0.1 mm thick but on the soles of the feet and the palms of the hands it can be 1mm thick or more. The main skin cell that makes up the epidermis is called the keratinocyte, thus named because it produces a tough protein called keratin. Keratin is also the protein from which nails and hair are formed. It gives skin much of its resistance to physical wear and tear and makes skin waterproof. ***(Lamberty et al.; 1990)***

Dermis

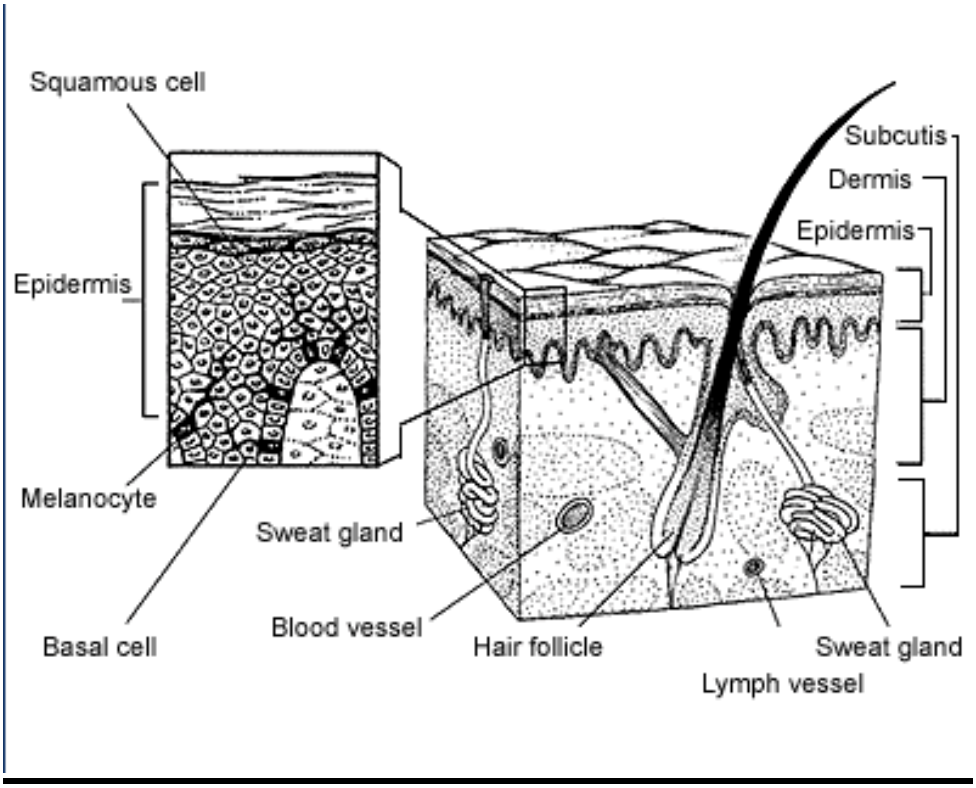
The dermis lies immediately underneath the epidermis and is about four times thicker. It contains numerous supporting tissues as well as blood vessels, nerves, hair roots and sweat glands.

Throughout the dermis other types of protein, notably collagen and elastin, give it strength and flexibility. A reduction in these proteins with age is normal and contributes to the more fragile skin of elderly people. Medications, in particular steroid drugs, also weaken the collagen fibers, causing thinning of the skin in the long term and an increased tendency to bruising. ***(Taylor et al.; 1998)***

Sensation and Blood supply

There are several types of nerve 'sensors' in the skin which have different functions. The simplest are free nerve endings, and are similar to bare wires in an electrical circuit. These detect pain, temperature and itch. Other more complex structures detect pressure or vibration. The distribution of nerves is not even throughout the skin, the highest density being found on the hands, face and genitalia. The effect of skin disease in these areas is therefore multiplied by the increased sensitivity of the skin here to sensations arising from the inflammation.
The supply of blood to the skin generally takes the form of microscopically small loops of blood vessels coming up from the deeper layer of larger blood vessels, each to supply a small local area of skin. The size of the blood vessels in these loops is controlled by signals sent through the nerves that accompany closing to them. Thus in temperature control it is possible for them to widen, increasing the flow and excess heat. If someone is cold or is exposed to a cold environment then contraction of the skin blood vessels cuts the amount of skin blood flow

and conserves body heat. All of this control activity occurs automatically by complex feedback systems involving temperature sensing tissues within the skin and the nervous system and brain. ***(Moore et al.; 1998)***



(Moore et al.; 1998)

Pathology

(1) Pathophysiology of electrical burn injury

Electricity is the flow of electrons (the negatively charged outer particles of an atom) through a conductor. An object that collects electrons become negatively charged, and when the electrons flow away from this object through a conductor, they create an electric current which is measured in ambers. The force that causes the electrons to flow is the voltage and it is measured in volts anything that impedes the flow of electrons through the conductor creates resistance, which is measured in ohms. ***(Arnoldo et al.; 2006)***

Electrical current exists in two forms, the alternating current (AC) and the direct current (DC). In the former the electrons flow back and forth through a conductor in a cyclic fashion. This type of current is the most commonly used form in households and offices, and it is standardized to a frequency of 60 cycles per second (60 Hz). ***(Ferreiro et al.; 1998)***

When the current is direct, the electrons flow in one direction. This type of current is produced by a various batteries and it is used in certain medical equipment such as defibrillator, pacemaker and electric scalpels. Although the (AC) is considered to be a far more efficient way of generating and distributing electricity, it is also more dangerous than (DC) Approximately three times because it causes tetanic muscle contractions that prolong the contact of the victim with the source. ***(Cooper et al.; 1995)***