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ЭЛЕКТРОТРАВМА
(патофизиологические аспекты)

ELECTRIC INJURY
(pathophysiological aspects)

Учебно-методическое пособие

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Приводятся сведения о свойствах электрического тока как повреждающего фактора, основные причины поражения током, рассматриваются вопросы патогенеза электротравмы и факторы, определяющие тяжесть поражения. Особое место уделяется проявлениям электротравм, отдаленным их последствиям и формам смерти при действии тока на организм. Приводятся сведения о поражениях от разрядов молнии, а также о принципах оказания первой помощи при электротравме.

Предназначено для студентов 2–3-го курсов медицинского факультета иностранных учащихся, обучающихся на английском языке.

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MOTIVATIONAL CHARACTERISTIC OF A TOPIC

Methodical recommendations are developed for the purpose of optimization of educational process and are recommended for training of students for practical class in a topic: «Damaging effect of electric current». This subject is considered in the section «General Nosology». Damage by electric current on a lethality and disablement borrows one of the first places among other injuries. In this regard detailed studying etiologies, pathogenesis, the mechanism of death, and the principles of first-aid at an electric injury gets the importance and is necessary for the doctor of any specialty. However in modern textbooks and guides these questions are stated incomplete and schematically, and in some guides they are absent. The aforesaid was also a reason for the edition of the present educational and methodical text-book.

Features of electric current as damaging factor, the most frequent reasons of lesion, the general characteristic of an electric trauma, and mechanisms of effect of a current and the factors defining severity of electric injury are given in the textbook. The special focus is attended for pathogenesis, manifestations, consequences, and mechanisms of death from electric injury. Data on chronic electric traumas, lesions from atmospheric electricity, and also about the principles of first-aid treatment are provided.

Lesson purpose: to study the general mechanisms, features and outcomes of damaging effect of electric current. To consider the main manifestations of damaging effects of electric current, change of structure and function of tissues and organs. To give a pathogenetic assessment of different types of electric traumas.

The student has to know:

– the features of electric current as damaging factor;

– the most frequent reasons of electric traumas;

– the factors defining severity of an electric trauma:

a) physical characteristics of current; voltage, strength, frequency, effect duration;

b) role of reactivity and resistance of tissues of an organism;

c) role of environment conditions (meteorological factors, etc.):

– local manifestations of damaging effects of electric current. Features of electric burns, their difference from the thermal ones;

– lethal outcome from an electric trauma: cardiac, respiratory form of death and death from electric shock. Concept of «imaginary death»;

– chronic consequences from electric injury;

– features of injury by a lightning;

– the principles of first-aid treatment at an electric trauma.

The student has to be able to give the reasonable conclusion about the fact and nature of injury by electric current on the basis of the descriptions of a clinical presentation, the general state, feature of «local» manifestations.

The student has to be acquainted with the course of an electric trauma, with features of damaging action of electric current in special conditions (changes of atmospheric pressure, ambient temperature, etc.)

Control questions of adjacent disciplines:

1. Notion about electric current. Technical and atmospheric electricity.
2. Key physical parameters of electric current. Units of measure.
3. Resistance of living tissue, its dependence on alternating current frequency. Polarization factor (coefficient of tissue durability).
4. Types of electric current. Concept of «step» voltage.
5. Electrothermal, electromechanical, electrochemical effects of electric current. Concept of electrolysis.
6. The basic principles of safety measures at the address with electric current.

Control questions:

1. Peculiarities of electric current as a damaging factor.
2. Factors affecting injury severity for the organism exposed to electric current.
3. Kinds of electric current injuries (local and general, specific and non-specific) and their characteristic. Pathogenesis of current injury.
4. The reasons of lethal electrocutions and their mechanisms. «Imaginary death».
5. Rules of giving the first-aid on electrocution.

FEATURES OF THE ELECTRIC CURRENT AS A DAMAGING FACTOR

A person can be exposed to technical or natural (lightning) electricity. Electric current has a number of features that define it's danger as a damaging factor. The electric current is:

1. Invisible, has neither smell, nor color, operates silently.
2. Able to turn to other kinds of energy (mechanical, chemical, thermal) and has a biological effects.
3. Not defined without special devices.
4. Has a damaging effect at direct contact, through subjects on distance.
5. Damages tissues not only at the point of entrance and exit but on the whole way of its passage through a body.
6. There is discrepancy between severity of damages and duration of its influence.
7. Means of electroprotection can become a damage source.

Electric injury (EI) — the damage caused by electric current effect on an organism, characterized by impairments of anatomical relationships and functions of tissue and organs and manifested by local and general reactions of an organism.

ETIOLOGY OF ELECTRIC INJURY

The reasons of EI are: imperfection and malfunction of protective adaptations, protection, isolation, violation of precaution rules, negligence, prank, indiscretion, accidents, mischief, direct contact or contact through a mouth or other conductor, inexperience, spark categories, lightning striking.

The impact of electric current on the body and the severity of damage are determined by: 1) the physical parameters of current, 2) body condition at the time of destruction, 3) characteristics of the environment.

The role of the physical parameters of the electric current. Changes in an organism in case of electric current traumas depend on

- voltage;
- resistance of tissues;
- current strength (I = V/R);
- type of circuit (alternating (AC) or direct (DC));
- duration of current effect;
- pathway of current distribution in an organism etc.

With voltage and current strength increase its harmful effect rises. The amperage passing through the body depends on body weight and tissue resistance.

Skin resistance in different parts of the body can range from 10 000 to 2 000 000 Om; resistance of the internal organs can range from 100 to 3 000 000 Om; bones possess the greatest resistance. The degree of resistance of the human body also depends on the integrity and skin hydration level, particularly, due to the perspiration.

Liquor, blood, nerves, mucous membranes and muscle have the least resistance. Dry skin, tendon and fat are characterized by intermediate resistance. Bones has a most resistance. The higher the resistance of a tissue to a current flow, the greater the potential for transformation of electrical energy to thermal energy.

Good water conductivity, high humidity plays an important role in the accidents. Non-conductive items moistened by the water acquire the ability to conduct current.

The magnitude of the resistance of the human body affects the central nervous system, altering the blood supply for organs and tissues, the secretion of sweat glands, etc.

There are certain areas of the body with an unusual (high) conductivity — «electric» receptors. It is the back of the hands, neck, temple, back and shoulder of the human. The muscular mass with the capillary network is the main current conductor.

In general, the consequences of electric current action on the body are determined mainly not by the absolute value of its voltage and resistance of tissue but their relationship, depending on which is the current power which passes through the human body.

Effect of AC and DC power is different. The most dangerous is an alternating current of a low frequency — 40–60 Hz. Damaging effect of the current is reduced with the frequency increase. High frequency currents even at high voltage are not dangerous and are used for therapeutic purposes (UHF, Tesla currents, d'Arsonval, diathermia, etc.). The alternating current of voltage up to 500 V is more dangerous, than a direct current of the same voltage. At voltage of 500 V damaging effect of an alternating and a direct current are approximately equal. At voltage of more than 500 V direct current becomes more dangerous than alternating one.

The maximum current that can cause contraction of the flexor musculature of the arm but still permits the man to release his hand from the current source is termed the «let-go» current. For direct current this value is about 75 mA; for alternating current, about 15 mA.

The damaging effect of the current is considerably determined by the duration of its action; with increasing time it increases. For example, the passage of high current and high power for 0.1 seconds and less does not always cause death. At the same time, current of the same strength and power for 1 sec. always leads to death. Thus, the maximum permissible current values depend on the time of human exposure. The examples of current effects are indicated in the table.

Table

Physical Effects of Different Amperage Levels at 50 to 60 Hz

Physical effect	Current strength
Threshold of perception	1 mA
Tingling sensation	1–4 mA
Maximum harmless current	5 mA
«Let go» current	10 mA
Tetany of skeletal muscles	16–20 mA
Paralysis of respiratory muscles (respiratory arrest)	20–50 mA
Ventricular fibrillation	60–120 mA
Asystolia	2–5 A
Defibrillation	6 A

Current pathways «current loops» have a great importance for the outcome of lesions. The most dangerous thing for the body is the passage of the current through the brain and the heart (at the beginning of diastole).

The most probable ways are: the lower loop (from leg to leg) (fig. 1, *8*) — the least dangerous; the upper loop (hand to hand) (fig. 1, *2*) — is more dangerous; the most dangerous — full loop (both arms and legs) (fig. 1, *10*, *12*). In the latter case, the current flows through the heart (fig. 1).

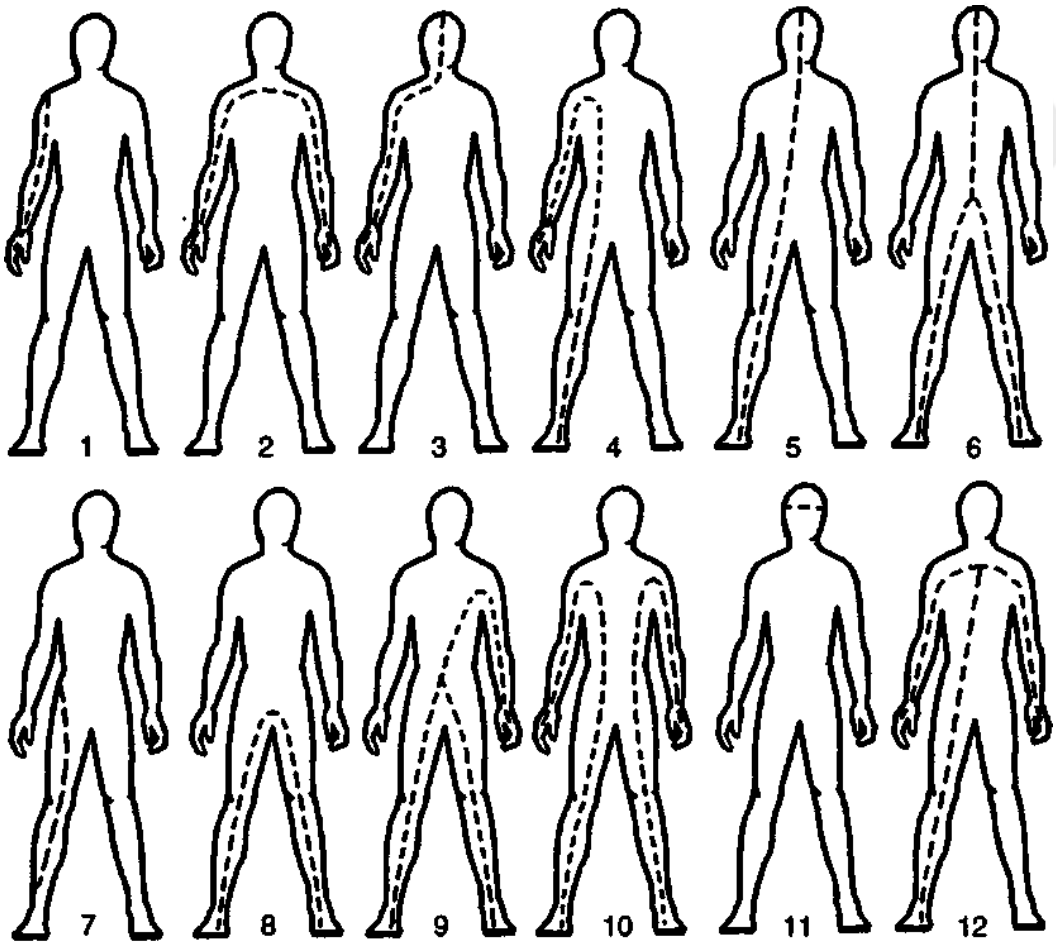

Fig. 1. Examples of different kinds of electric loops

The lethal outcome can come at all kinds of loops since an electric current, passing through an organism, irritates all receptors lying on its way. In case the current passes through all systems and bodies, the nervous and cardiovascular systems suffer the most.

The value of organism reactivity. EI consequences largely depend on the functional state of the organism and its sensitivity to electrical current, which is determined by several factors, most important of which is the state of regulatory systems — the nervous and endocrine ones. In many cases, a factor of attention, readiness, expectation of electric current shock plays a critical role.

Electricians are known to touch electrical wires to make sure there is power in them and survive this manipulation without consequences.

However accidental contact and unexpected current impacts can cause severe disorders or death in the same people.

Mechanism of this phenomenon is not completely understood. It is believed that psychic shock which reduces the body resistance occurs in case of damaging by unexpected electric current.

Possibly the formation of the defensive dominant plays its role in the «preparedness» for the current action, which inhibits its effect.

It is suggested that attention factor increases blood circulation in the central nervous system, increases oxygen consumption, which in turn increases the number of electrons in the process of biochemical reactions.

Such explanations are legitimate, primarily, in damaging with current voltage of 220–380 V; for its larger values, the factor of attention is unlikely to be significant.

The severity of the damaging effect of electric current on the body is largely determined by the functional state of the nervous system. It is known that anesthesia, deep drunkenness, a state of «hypnotic sleep» protects people and animals from the effects of electric current, reducing sensitivity to it. Increase of the nervous system excitability due to feeding rabbits by thyroidin increases sensitivity of animal to electrocution.

In case of thyrotoxicosis, hyperthyroidism, fatigue, emaciation, edema, hyperhydrophilicity, mental and pain traumas, cardiovascular insufficiency and blood loss the sensitivity to electrical current increases dramatically.

The role of the environment during electrical accident. Injury by electric current occurs in certain environmental conditions which significantly influence on the severity and outcome of EI. So, the risk of electric currents clearly increased by an overheating of the body, accompanied by excessive perspiration.

In case of overheating decrease of resistance to EI, probably, is associated with the increase of excitability of vasomotor and respiratory centers. In overheated animals death from EI develops more often from primary heart arrest. On the other hand, cooling (in the t medium — 10 °C) reduces the risk of electric shock. Increase of the threshold of electric current at hypothermia and its sharp decrease during hyperthermia was found. In summer period EI has more severe consequences, and traumatism from electric current increases. In countries with hot and humid climate and in the north areas with frequent fogs and large amount of fall-outs affections by electric current occur more frequently and have more severe consequences.

Level of atmospheric pressure influences on the severity and outcome of EI. Thus, in elevation of atmospheric pressure in a submarine environment and in the stratochamber resistance of animals to EI is high. This is associated with the elevation of the partial pressure of oxygen in the inspired air, the increase of oxygen supply to the body. On the other hand, in case of reducing of atmospheric pressure (and reducing of the oxygen partial pressure as hypoxia develops) the risk of EI significantly increases. In the latter the electrical conductivity of air is of great value.

Meteorological factors can increase or decrease the conductivity of electrical current in the body. The situation and room conditions in which EI appears are very important. In the basement with moist earth floor resistance is much less; hence, probability of a large current flow through the body is much higher.

Leather, rubber, wool and silk clothing are good insulators.

All these facts suggest that it is hard to define absolutely dangerous and completely safe amount of current because the severity of damage is determined by a number of factors and their combination and interaction. Most authors believe that currents higher than 0,1–0,5A are certainly lethal.

PATHOGENESIS OF ELECTRIC INJURY

Electric current has specific and nonspecific effects on the body.

Specific effect of the current is shown in the biological, electrochemical, electrothermal and electromechanical effects caused by the redistribution of ions (vibration effect).

Biological effect of the current is in its impact on the excitable tissues and primarily on the nervous system and organs of internal secretion. Large amount of catecholamines (epinephrine, norepinephrine) is released, somatic and visceral functions of the body are changed, skeletal and smooth muscles are excited, tonic spasms of skeletal and smooth muscles develop. Biological effect influences to the potassium-sodium gradient of cells and membrane potentials, affects the occurrence of excitation and other phenomena in the cell.

Electrochemical (electrolytic) ***effect*** of the current is shown in the fact that the current overcoming the resistance of the skin, penetrates the tissues, causes electrolysis, impairment of ion balance in the cells, change the transmembrane potential. Changes in the distribution of ions considerably change the functional state of the cells. A movement of protein molecules occurs, as a result acid consumes water and coagulation of proteins (**coagulation necrosis**) develops. In parts of the alkaline reactions, swelling of colloids occurs and **colliquative** tissue **necrosis** develops.

Electrothermal effect of the current is due to the transition of electric energy on passing through the tissues of the body to heat one with a great amount of heat liberation. Damages of the skin — *signs of the current* (electric signs) — areas of coagulation of the epidermis — round or oval forms, grayish-white color, firm consistency, borded by a rolled height, retraction in the center are appeared (fig. 2). Sometimes electric signs are abrasions, flesh wounds with the carbonized edges. Sometimes — foci of destruction, reaching into the depths of «electric marks along length» like a gunshot wound, in which the tissues are smashed, torn off.

Fig. 2. As a result of electric injury there are skin damages — signs of current (electric labels) are revealed

Sometimes the focus of destruction is like the prepared area of the body (dissecting current action). Current signs are found in 70–75 %. They may be burns of the skin of all levels up to the charring, melting bone tissue with the release of calcium phosphate and the formation of the so-called *bone («pearl») beads* (fig. 3).

Fig. 3. Formation of bone pearl under the influence of electrolysis. Arrow indicates on the calcium phosphate bubble. A histologic picture of an bone with bone beads

One can meet: current passages into the bone, nail splitting tuberosity of terminal phalanges, distortion of bones, sequestration, the formation of «bone pearls», spontaneous amputation of bone segments, osteoporosis, and decalcification.

Electromechanical (dynamic) ***effect*** of the current can be done in two ways: by a direct transition into mechanical energy and an action of a forming steam and gas. It can be an exfoliatation of tissue, even separation of some parts of the body, formation of incised wounds, fractures, dislocation of joints, skull injuries, concussion, etc. (fig. 4). The combined effect of a thermal and mechanical energy has an explosive effect; an increased pressure of air masses can throw the man to the side.

Fig. 4. Electromechanical electric damage of thigh; example of tissue stratification and separation of body parts

Nonspecific effect of the current — this is an action due to other forms of energy, in which the electricity outside the body is converted. Thus, thermal burns can appear from the hot metal conductors, electric arc (400 °C) from the burning of clothes and a gas explosion. As a result of radiation by voltaic arc light, ultraviolet, infrared rays can cause a burn of the cornea, conjunctivitis, optic atrophy. From a strong sound on an explosion — damage of hearing organ, from falling down — broken bones, sprains, bruises, injuries of internal organs, compression and avulsion fractures because of spastic contractions of muscles at EI moment and etc.

Electric current causes local and general changes. However, the division is considered conditional because «local» events in most cases are accompanied by marked general changes.

There are early changes occurring on the electric current coming and during the first 2–3 hours after the EI, and late ones appearing in a few days or months. Electric current acts directly on the damaged cells and tissues and indirectly, irritating receptors lying on its path and causing reflex reactions which go far beyond its application (biirradation). Along with rough anatomical abnormalities, the electric current causes changes in cellular structures at the molecular and subcellular levels.

It is believed that in the pathogenesis of EI not only the ionization of atoms and molecules, but also changes in the electrical potential of organs and tissues have a value.

Depending on the conditions the electrical current can carry on the whole pathologic process to the end (death) and can act only as a trigger factor (e. g. staying a victim in a shock after turning off the chain).

Local effects. Local effects are appeared mainly in electric burns. It is specific contact electric burns arising from a heat when a current is passing through the tissues providing resistance to the electric current, and non-specific (thermal) burns which occur on being exposed by the electric arc flame (fig. 5).

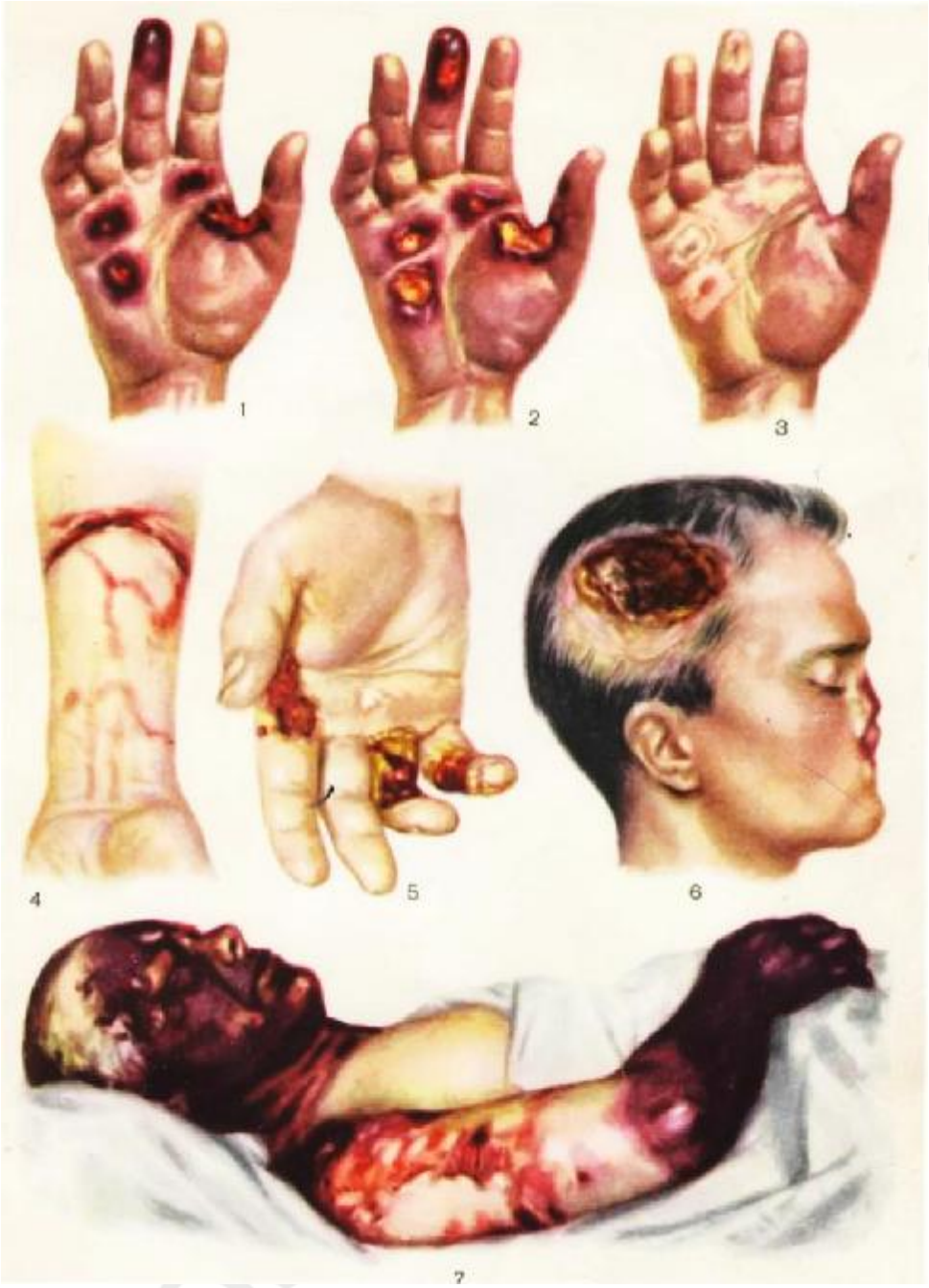

Fig. 5. Contact electrical trauma at infringement of insulation of an electric iron (220 V). Signs of electric current:
1 — before treatment; *2* — during treatment; *3* — after heating; *4* — contact electrical trauma (220 V). Electric current signs are on the forearm; *5* — signs of current in electrical trauma from plug wire (220 V); *6* — contact electrical trauma of the face and the scalp with bone damage, amputation of nose tip; *7* — burn caused by the electric arc of the face, neck and the upper limb on repairing the electric device under an electrical voltage of 380 V

Electrical burns have a number of features distinguishing them from thermal burns: they usually occur at the points of current input and resemble the shape of the conductor, which came into the contact with the body. Accordingly, at the points of current input a metal impregnation into the skin

can be observed. Destruction of metal and penetration of its smallest particles into the skin occur under the influence of mechanical and chemical action of the current. In this case, the skin turns on different colors: greenish — in contact with brass, gray-yellow-brown — in contact with lead. Electric burns are characterized by a typical small pain or absence of pain, which is extremely marked in thermal burns, due to *anesthetic action of current* (parabiosis of the nerve receptors and conductors).

Electrical burns are divided into 4 degrees: first-degree burn — skin reddening and signs of a current (electro labels); second-degree burn — epidermis exfoliation with vesicle formation (fig. 7); third-degree burn — coagulation of the whole derma thickness (fig. 6); fourth-degree burn — damage caused not only to derma, but also to tendons, muscles, vessels, nerves, bones (up to carbonization) (fig. 7).

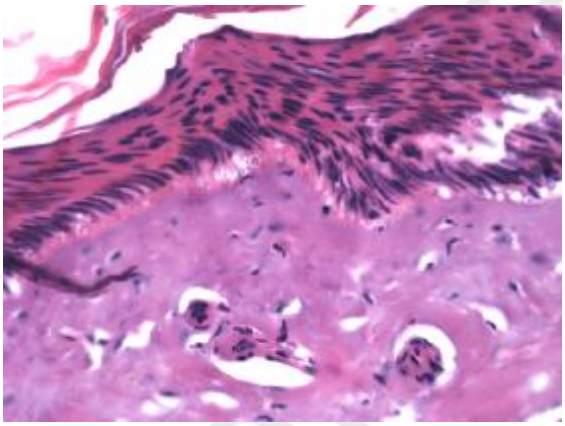

Fig. 6. A histologic picture of an electrical burn showing elongated pyknotic keratinocyte nuclei with vertical streaming and homogenization of the dermal collagen (40×). Courtesy of Elizabeth Satter

Fig. 7. Four degrees of electrical burns

The process of disintegration and abruption is not limited by clearly affected areas, but goes further extending the original boundaries in 2–3 times. Healing comes much better than in thermal burns, wounds don't tend to suppuration, though sometimes can be complicated by profuse bleeding due to the damage of the vascular walls.

In this case, there is a risk of death in the convalescent. Soon, after the damage by electric current (sometimes in 2–3 weeks) necrosis of the skin and muscles, involving the bone can develop. Necrotic tissue is quickly mummified and is separated from the healthy tissue by the demarcation line. In some cases, the situation is aggravated by developing of proteolysis and absorption of waste products of their own body tissues.

If there are considerable muscle damage and complications caused by the infection any risk of traumatic intoxication (like at crushing of tissues) may occur. Deep electric burn involving the brain can be accompanied by the inflammatory changes in the meninges and local lesions in the central nervous system (CNS).

Late local complications are rough scar deformations with the development of contractures.

The common effects. In case of EI common effects are manifested in changes of the psychics, disorders of the central and peripheral nervous system, cardiovascular and respiratory systems, internal organs, permeability of the vessels, blood changes, convulsions. Subjective changes can be different: itching in the fingertips in contact with the conductor, burning pain, tremor, trembling. Spastic contraction of muscles can develop.

Current allowing hand's decompression which holds a wire — «releasing». Spastic contraction of muscles «pulls up» the victim to a power source.

«Pulling up» effect makes impossible to release from the current source, this fact greatly increases the time of its current effect and aggravates EI.

If the «pulling up» occurs in holding for the wire of the high voltage, the skin on the hands becomes black, «peels off» («glove of death»), consciousness becomes darkened, accompanied by the motor excitation. About 80 % of the victims lose their consciousness; most of them recover their consciousness after switching off the network without any special events. Prolonged loss of consciousness (a few hours or even days) is usually observed when the current passes through the brain.

People that have survived EI may experience a variety of disorders: pale skin, cyanotic lips, cold persperation, fatigue, apathy, adynamia, feeling of weakness, malaise, heaviness in the body, general depression or excitement, retrograde amnesia, hysteria, increased intracranial pressure and cerebrospinal fluid pressure, headache, photophobia, etc. It can be observed subarachnoid hemorrhage, focal lesions of the brain and spinal cord, traumatic encephalopathy, parkinsonism, acute cerebellar ataxia, impaired spinal cord

conduction. There are (in case of low voltage effect) spinal atrophic processes associated with hematomyelia — muscle atrophy, sensory disturbances with vasomotor and trophic disorders and sometimes pelvic disorders.

Abnormalities in the central nervous system may be associated with the direct passage of current, impairment of blood circulation and respiration, as well as the severe psychic trauma disorders.

In case of nonfatal EI, the presence of transient electrocardiographic coronary insufficiency is established by electrocardiography regardless at the type of the loop the electric current passes. Myocardial infarction may occur with subsequent development of atrial fibrillation with coronary pain. Therefore a man, suffered electric shock, even if he feels good, cannot be left without medical supervisor and allowed to go home, but must be hospitalized at least for three days, because he should be considered seriously ill.

In peripheral blood there is leukocytosis, changes in complete blood count, appearing of pathological forms of cells. There may be respiratory disorders, traumatic emphysema and pulmonary edema, functional impairment of the liver, lesions of intestine, kidney, urinary bladder; swellings, hydroarthrosis. Infertility, hair loss and hypertrichosis on the affected limb can be noticed. From the sense organs — vestibular disorders (dizziness, persistent), neuroretinitis, horeoretinitis, optic neuritis, cataract.

National and foreign clinicians have noted that systemic damage at EI with extensive burns comes milder than without burns. This fact can be explained as the charring of tissues creates a significant barrier for penetration of the current with great destruction of all extero- and interoreceptors located closer to the site of damage and as a result a reflex component falls out.

In EI the electric current with great strength, death can occur in 2–3 minutes after the injury, but the sudden death can occur after a period of very good subjective and objective conditions.

THE CAUSES OF DEATH FROM CURRENT

Death can occur from: a) a primary cardiac arrest (cardiac form of death), b) primary respiratory failure (respiratory form of death), c) the simultaneous cardiac and respiratory (mixed form of death), d) electric-traumatic shock.

Cardiac form of death may be due to: a) irreversible ventricular fibrillation, b) spasm of the coronary arteries, c) vasomotor center lesion, d) increased tone of vagus nerve.

Experimental studies have shown that the heart is «vulnerable» for the electric current only during refractory period, which falls on the «T» wave on ECG.

In cardiac death the color of the victim’s skin is white as blood stops quickly, oxygen supply to the tissues doesn’t occur, and normal maintenance of

the reduced hemoglobin does not change skin colour. In human electric fibrillation danger does not subside spontaneously (in most cases) and requires specific extra urgent means for its removal.

In small animals (mice, rats, guinea pigs, rabbits, cats and even macaque monkeys) ventricular fibrillation is reversible. In large animals, comparable in weight with the weight of human (dogs, sheep, pigs, calves), ventricular fibrillation doesn't stop spontaneously.

The ***respiratory form of death*** during EI may have different pathogenetic mechanisms: a) inhibition or paralysis of the respiratory center, b) spastic contraction of the respiratory muscles, spasm of the glottis, c) a spasm of the vertebral arteries feeding the respiratory center, d) electric asphyxia — an impairment of the airway due to laryngospasm. In primary respiratory arrest cyanosis of the skin associated with the accumulation of reduced hemoglobin can develop.

The ***mixed form of death*** is developed during simultaneous failure of the heart and respiration. Paleness of the skin as in the form of cardiac death is noted. The damage of the respiratory and vasomotor centers at EI is due to both the direct damage to the nerve cells as a result of their membrane depolarization and coagulation of the cytoplasm and the reflex effect of extero- and interoreceptors.

Death from ***the electrotraumatic shock***. EI just like any other injury of shock genicity leads to neurogenic phase changes in the body. Picture of shock occurs in short-term touching of current conducting objects of human, if neither atrial fibrillation develops nor breathing stops. In more prolonged passage of current shock can develop due to a sharp pain caused by stimulation of receptors, nerves, painful muscle cramps and spasm of blood vessels (ischemic pain). In the electric shock changes of function come in two-phase flow. **First** (**erectile**) **phase** is characterized by *central nervous system stimulation*, increased arterial and venous pressure, shortness of breath, convulsions, which may continue after the power was switched off. Convulsions are related to striated and smooth muscles, so involuntary urination and defecation can develop. In some cases (if the current passes through the brain) convulsions are similar to epileptic seizures.

Phase of excitation is particularly marked and is prolonged with the current of a low intensity. With the current of a high intensity (100 mA and above), this phase is short-term and the **second (torpid) phase** dominates — *central nervous system inhibition*, a sharp decrease of blood pressure, respiration inhibition, inhibition of all vital functions until the loss of consciousness and the state of «imaginary death» when breathing and heartbeats stop, reflexes disappear. Imaginary death can turn into the natural death, biological.

Pathogenesis of apparent death is not completely understood. In the imaginary death life goes on, but the intensity of its manifestations is negligible. A feature of the imaginary death is a possibility to bring back to life a man seemed dead, using appropriate therapeutic measures. It is believed that an electric current produces a sharp limiting inhibition of the nervous system; it has a protective effect and makes possible the existence during minimum oxygen consumption level.

Most researchers identify the state of the imaginary and apparent death. However, some authors differentiate these terms, considering that in the imaginary death the main systems providing life — blood circulation and breathing are functioning at a minimum level (the man is alive, but shows the impression of dead), while in the apparent death both systems are not functioning.

CHRONIC ELECTRIC TRAUMAS

Exposure to electric current can cause chronic EI. Long stay in the electric fields which are formed near the power generators UHF, may contribute to early atherosclerosis, rigidity of the peripheral vessels, etc.

Symptoms of chronic EI — headache, fatigue, feeling of weakness, sleep disorders, state of confusion and inability to concentrate, forgetfulness, heart pain, weight loss, and in some cases — dilated pupils, trembling limbs, decreased or increased sensitivity in the distal extremities, low blood pressure, slow heart rate, persistent red dermographism, menstrual cycle disturbances, monocytosis as well as dryness of the conjunctiva, the feeling of sand in the eyes, sometimes sharp temporary visual disturbances.

Injuries from discharge of atmospheric electricity (lightning). Lightning is a giant discharge of atmospheric electricity. Each storm cloud over the earth is charged by it. Atmospheric voltage electricity reaches millions of volts; current is measured in hundreds of thousands of amperes.

Lightning speed is 100 000 km/h (one-third of light speed), and t is 6 times higher than the surface of the sun, so each subject caught by lightning is almost always burnt. Duration of the discharge is a split of second, rarely reaching one second.

Affecting factors of atmospheric electricity are electric current, light and sound energy, shock wave. In general, the action of lightning is similar to the action of an electric current of high voltage. Except some cases due to enormous energy and the explosions shaking the air some parts of the body are seriously damaged mechanically and even come off the body, and a man is thrown to a long distance.

The same effect can arise from spastic contraction of the skeletal muscles by a direct lightning stroke. In addition, deep and prolonged loss of

consciousness, respiratory arrest, cardiac depression, considerably more common symmetrical motor disorders of the peripheral nerves, predominant appearance of them in the lower limbs (paralysis, paresis) are characteristic for the action of lightening.

The current signs on the skin and burns on affecting by lightning have bizarre form, and are characterized by a long extension. During the current dendritic branching dark red or pink signs of current — lightning figures (fig. 8), disappearing with pressure is formed. They are believed to develop as a result of local paralysis of vessels and small hemorrhages. Lightning figures persist up to two days, and then gradually become pale and disappear.

Fig. 8. The back of a man who was struck by lightning

THE MAIN STEPS OF FIRST HELP THE VICTIMS FROM ELECTRIC INJURY

1. If safely possible shut off the electrical current, unplug the cord, remove the fuse from the fuse box or turn off the circuit breakers.

Simply turning off an appliance may not stop the flow of electricity.

2. Call for medical help.

3. If the current can't be turned off, use a non-conducting object, such as a broom, chair, rug, or rubber doormat to push the victim away from the source of the current. *Do not use a wet or metal object*. If possible, stand on something dry and non-conducting, such as a mat or folded newspapers. *Do not attempt to rescue a victim near active high-voltage lines*.

4. Once the victim is free from the source of electricity, check the victim's airway, breathing, and pulse. If pulse has stopped or seems dangerously slow or shallow, start first aid.

5. If the victim has a burn, remove any clothing that comes off easily, and rinse the burned area in cool running water until the pain subsides. Give first aid for burns.

6. If the victim is faint, pale, or shows other signs of shock, lay him or her down, with the head slightly lower than the trunk of the body and the legs elevated, and cover him or her with a warm blanket or a coat.

7. Stay with the victim until medical help arrives.

8. Electrical injury is frequently associated with explosions or falls that can cause additional traumatic injuries, including both obvious external injuries and concealed internal injuries.

Avoid moving the victim's head or neck if a spinal injury is suspected. Administer appropriate first aid as needed for other wounds or fractures.

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