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Chapter 1

TRAUMA AND EVOLUTION OF ITS TREATMENT MODALITIES

Trauma

Trauma (or injury) is the impact on the body of various external factors that leads to a violation of the structure, anatomical integrity of tissues and physiological functions.

Injuries are divided into acute (the result of a momentary, sudden impact of an external factor) and chronic (as a result of constant and repeated exposure to the same traumatic agent on a certain part of the body).

Depending on the type of damaging factor, injuries are distinguished in mechanical, thermal, chemical, radiological, biological, etc. In this manual, mechanical and thermal injuries will be considered.

The effect of an external factor is influenced by the nature and duration of exposure, the direction of the traumatic force, the kinetic energy of the traumatic agent.

Mechanical injuries are classified by several characteristics depending on:

- ▶ the point of application of the force — direct (at the place of application of the force) and indirect (at a distance from the point of application of the force) (Fig. 1.1);

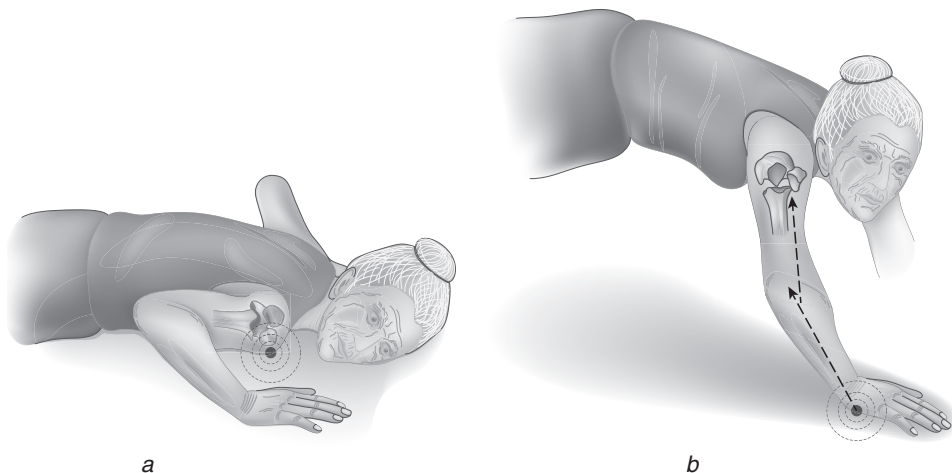


Fig. 1.1. Mechanisms of trauma: a) direct; b) indirect

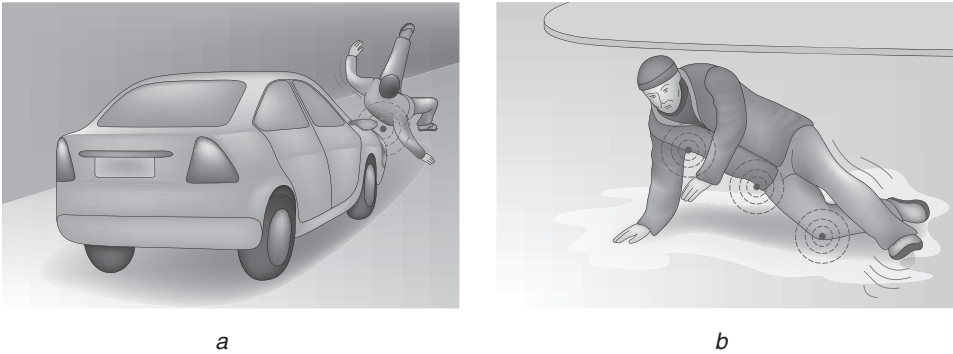


Fig. 1.2. High-energy (a) and low-energy (b) trauma

- ▶ the amount of kinetic energy acting on tissues — high-energy trauma (car accident, falling from a great height, gunshot wound) and low-energy trauma (Fig. 1.2);
- ▶ the action of mechanical force — compression, twisting, stretching, impact;
- ▶ the nature of tissue damage — bruise, rupture, fracture, dislocation, wound;
- ▶ the type of damaged areas of the body — cavity trauma (damage to the organs of the abdominal, thoracic cavities, cranial cavity) and skeletal trauma (damage to bones, joints, skeletal muscles);
- ▶ the number of damaged organs — isolated (damage to one internal organ or injury within one segment of the musculoskeletal system) and polytrauma (in turn, divided into multiple, concomitant and combined; this classification will be discussed in more detail in Section 4.1 "Polytrauma").

Traumatism

Traumatism presents the aggregate of injuries in certain groups of the population or in a contingent of persons who are in the same environment, the same type of working and living conditions for a certain time span. There are causal relationships between external conditions (work, sports, features of everyday life, use of transport, etc.) and the condition of the body (nutrition, age, chronic diseases, climatic features), permitting to study and predict the nature and frequency of injuries in a certain contingent of people and take preventive measures (Table 1.1).

Children's traumatism is especially standing out, where, in addition to all the listed types (mainly non-industrial) injuries, there are labor (during childbirth) and school injuries (during the child's stay in school or a preschool organization, or *en rout*). When studying children's traumatism, the following age groups are described: infancy (up to one year), nursery (from one to three years), preschool (from three to seven years), school (from 7 to 16).

The injury rate is determined by the number of injuries per 100 or 1000 people for a certain period (month, year). The injury frequency rate at the enterprise is calculated by dividing the number of injury cases in the reporting period by the total number of employees.

Table 1.1. Types of traumatism

I. Production (related to professional activities)	Industrial — at industrial enterprise. Agricultural — during working in agriculture. Transport — while working on transport vehicles. Construction — during construction. Other — in employees of other industries
II. Non-productual (not related to professional activity)	Traffic accidents — due to transport vehicles. Outdoor — on the street, in the field, in the forest, in public places. Household — in the house and in the yard of the house, in apartment, personal garage. Sports — when doing sports
III. Intentional — crimes, terrorism, suicides, and self-harm	
IV. Military — during the military operations	
V. Pediatric	

The highest injury rate is observed in men in the age range of 20–50 years, and in women — 30–60 years, and, for all age groups, men's traumatism rate is significantly higher comparing with women.

In Russia, the total number of injuries exceeds 10 million cases per year. The provision of medical assistance, treatment and rehabilitation of victims require the involvement of large funds, material, and human resources. Therefore, great attention should be paid to the prevention of injuries, the identification of their causes.

Industrial injuries are primarily associated with working conditions, serviceability of equipment, control over compliance with safety regulations. In non-occupational traumatism, the share of road traffic injuries is growing. Despite preventive measures, road traffic traumatism today presents a serious problem of global importance. The main role in the occurrence of road accidents belongs to the human factor: over 90% of injuries in road traffic accidents occur through the fault of people. Social tension in society, political events in the world have led to an increase in intentional and military injuries in recent years.

Evolution of trauma treatments

History

Traumatology as a kind of "system" of skills is one of the most ancient branches of human knowledge. During the excavations of the sites of ancient people, the skeletons with traces of trepanation holes in the skull, with amputated limbs, and healed fractures were discovered. The analysis of the findings has demonstrated that after injuries people were living relatively long, and, for the treatment of some injuries, they had already used reliable immobilization.

The investigation of the mummies of Ancient Egypt showed a rather high development level of medicine in that period. 6000 BCE, they successfully performed amputations, craniotomy, applied hardening dressings for fractures. For wounds treatment,

they used honey and oils. A papyrus, belonging to the era of the Middle Kingdom, i.e., written in 2000 BCE, describes a number of surgical operations, as well as 48 types of injuries.

"Ayur-Veda" — "The Book of Life" (India, 6th-2nd centuries BCE) reveals the high level of ancient Indian healers. During the reign of Ashoka (3rd century BCE), hospitals were organized at Buddhist temples. Doctors had experience in the limb amputation; in the treatment of fractures, they used traction and counter-traction, fixing bandages and bamboo splints. For surgical interventions, ancient Indian doctors used about one hundred different instruments; tissues were not only dissected, but also sewn with special needles and sutural material. Evidence of plastic surgery of the nose, ears and lips has survived to this day.

Surgery reached a high level of development in ancient Greece, especially in the classical period. The contribution of the "father of medicine" Hippocrates who lived in the 4th century BCE is extraordinary. Ancient Greek physicians were mainly involved in the area of surgery, which today includes traumatology and desmurgy. In the essays "On fractures", "On head wounds", "On the reduction of joints", "On the lever", Hippocrates described in detail the symptoms and methods of treating dislocations, fractures, not only by manual methods but also using various mechanical lever devices. After dislocation's reposition, a reliable immobilization was recommended. In cases when the reposition of the broken fragments for open fracture was impossible, Hippocrates recommended sawing off the contaminated end of the bone protruding into the wound. From conservative methods of treatment, sunbathing, rubbing, and tapping on the bone were recommended. Much attention was paid to the strict cleanliness of the bandages.

Ancient Rome took over the baton from Ancient Greece in all areas of culture, science and medicine. In the 1st century a treatise "On Medicine" was written, the author of which was Aulus Cornelius Celsus — a free Roman from a noble family. In the 8th book of the treatise, Celsus deals with the issues of bone surgery and traumatology. He deepens the idea of Hippocrates about wounds, complements the concept of operations on bones by scraping, resection of contaminated and affected areas to "pinpoint bleeding", gives a description of a number of tools for surgical manipulations: a trepan for operations on the skull, a chisel, a hammer, resection forceps. Celsus constantly took care of measures to prevent the possibility of gangrene and joint stiffness. For open fractures, he considered the treatment of the wound as the most important task of the surgeon: "The wound should attract more attention than the bone". In case of improper fusion of the bones, he recommended resorting to a second fracture. For the immobilization of the shin bones, Celsus for the first time offers grooved splints with a foot support gripping the knee joint. The presentation of clinical questions by Celsus is preceded by anatomical references exceeding in accuracy the same sections of the books by Hippocrates.

The Roman physician Galen (AD 130–210) lived almost at the same time as Celsus. In addition to his huge contribution to medicine in general, he described the twisting of a vessel to stop bleeding, silk sutures, and the technique of some types of plastic surgery. We are also indebted to him for the appearance of the terms "lordosis", "kyphosis", "scoliosis".

After the collapse of the Roman Empire, the development of medical science stopped for centuries and started again in the East reaching its greatest success during the Arab Caliphate period. The most prominent figure of this era was Abu Ali al-Husayn ibn Sina (980–1037). In Europe, he is known as Avicenna. He wrote more than a hundred of books that represent a significant contribution to world culture in all branches of human knowledge, 16 of them are medical, including the "Canon of Medicine", which remained as a guidebook and source of knowledge for physicians of the East and West until the 18th century. Avicenna describes the symptoms and gives a clear definition of bruises, sprains, dislocations, fractures, presents methods of their treatment, including the technique of fractures setting and dislocation reduction.

The further development of surgery, and traumatology, took place in the Renaissance era and is closely connected with Ambroise Paré who was born at the beginning of the 16th century and is rightfully called "the father of modern surgery". In 1545, he published a manual on battlefield surgery "A way to treat gunshot wounds, as well as injuries inflicted by arrows, spears, etc.". The second immortal merit of Paré should be considered his teaching on amputations and methods for stopping bleeding by ligating blood vessels. He gave a detailed presentation for the prostheses and orthopedic devices, initiated the use of antiseptic agents, described a number of operations.

In Russia, in ancient times, injuries were assisted by applying bandages, sticks. Treatment was provided by magicians, healers. In the days of Kievan Rus, monks were engaged in treatment. Thanks to their knowledge of languages, ties with Byzantium, they were familiar with the works of Hippocrates. Surgery in Russia began to develop in the 17th century. The wars waged by the state at that time required the training of medical personnel to provide assistance to the wounded. In August 1654, the first Moscow medical school in Russia was founded, which had two departments — medicine and bone-setting. In 1707, by order of Peter I, a hospital was opened in Moscow "across the Yauza River opposite the German settlement". Under it, the first medical and surgical school in Russia was created. In 1733, a medical and surgical school was opened in St. Petersburg. In 1764, a medical faculty was opened at Moscow University, where, along with general medical disciplines, bonesetting was taught.

Key points in the development of traumatology and orthopedics

The efforts of many outstanding scientists and doctors led to the formation of traumatology and orthopedics as an independent branch of medical science and practice. It is not the purpose of this tutorial to provide a detailed account of all the discoveries and achievements along the way. Let's pay attention only to the key pivotal moments.

For a long time, the possibilities of surgical treatment of injuries were limited by the absence of anesthesia; therefore, preference was given to reposition of bone fragments and dislocations with subsequent external immobilization. Forced amputations of limbs without anesthesia often led to death, and the chest and abdominal cavities were "forbidden zones". Only the high quickness of the surgical intervention improved the patient's chances for survival. This required an excellent knowledge of anatomy and virtuoso technique from the surgeon.