

Ministry of Education and Science of Ukraine
V. N. Karazin Kharkiv National University

FORENSIC MEDICINE

**Methodical guidance
for the 4th year medical students
in discipline “Forensic medicine. Medical legislation”**

Electronic resource

Kharkiv – 2023

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F 75 **Forensic medicine** : methodical guidance for the 4th year medical students in discipline “Forensic medicine. Medical legislation” [Electronic resource] / compilers O. S. Protsenko, N. O. Remnyova, M. V. Gubin, A. V. Kis, N. O. Tkachenko – Kharkiv : V. N. Karazin Kharkiv National University, 2023. – (PDF 64 p.)

Methodical guidance includes the theoretical part of the cycle of practical classes in forensic medicine. The following guidance provides medical students with procedural basics, forensic thanatology, forensic traumatology, falling from height, damages caused by blunt or sharp objects, forensic-medical examination of firearm injuries, and mechanical asphyxia.

The guidance is recommended for IV year students of the School of Medicine.

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CONTENTS

Chapter 1. FORENSIC MEDICINE SUBJECT. HISTORY OF ITS DEVELOPMENT	4
Chapter 2. PROCEDURAL REGULATIONS OF FORENSIC MEDICAL EXAMINATIONS	7
Chapter 3. FORENSIC-MEDICAL THANATOLOGY	10
Chapter 4. FORENSIC TRAUMATOLOGY	18
The damages formed from influence of blunt objects	20
Damages caused by sharp objects	38
Forensic-medical examination Of firearm injuries	45
Chapter 5. FORENSIC-MEDICAL EXAMINATION OF MECHANICAL ASPHYXIA	53
Literature	62

Chapter 1

FORENSIC MEDICINE SUBJECT. HISTORY OF ITS DEVELOPMENT

• **Forensic medicine (FM)** - branch of a medical science which is engaged in treating of the questions arising in civil and criminal practice, resolved only by means of medical knowledge.

• **Forensic medical examination** it scientifically-practical research by the forensic medical expert on the basis of knowledge of medico biological character made under the decision or a direction of judicial-investigatory agencies, for drawing up of the conclusion concerning questions of medical and biological character arising during the activities of judicial-investigating agencies.

The forensic medicine subject includes following sections:

- 1. Introduction.
- 2. History of development of forensic medicine.
- 3. Legal procedures and organization of forensic-medical expertise (FME).
- 4. Damages and death from various kinds of external influence.
- 5. The Forensic-medical examination of alive persons.
- 6. The Forensic-medical examination of corpses.
- 7. The Forensic-medical examination of material evidences.
- 8. The Forensic-medical examination on materials of judicial and investigatory cases.

Forensic medicine tasks

- The help to justice in disclosing of crimes against the person.
- The help to public health departments to improve quality of treatment-and-prophylactic work.

Features of forensic medicine

- 1. FM it is closely connected to many theoretical and clinical disciplines.
- 2. FM has universal character in sense of objects and research methods.
- 3. FM has official character.

Forensic medical expert is the individual having the doctor degree who has passed a special training and works as a forensic medical expert in the bureau of medico-legal examinations.

Forensic-medical examination's objects: a corpse, the living person, material of cases, material evidences.

The kinds of medico-legal examination:

Initial – it is a medico-legal research of the subject with the conclusion based on its results; it is carried out first.

Additional – it resolves the questions arising because of insufficient clearness or incompleteness of the initial medico-legal conclusion, in case new data of preliminary investigation are obtained.

Repeated (second) – it is carried out if the conclusion of initial examination is inconsistent or doubtful (it is entrusted to another expert or other experts).

Commission – it is carried out in difficult criminal cases with participation of several specialists - doctors (usually when medical workers are brought to criminal account for professional offence).

Complex Examination – it is provided with participation of experts of various branches of science and technology (chemists, criminalists, motor technicians, etc.).

History of domestic forensic medicine

- **The periods:**

- From Peter I before judicial reform 1864r.
- From judicial reform of 1864 before October revolution.
- 1917-1939 (Second World War beginning).
- 1941-1945 (Second World War) - 1991 (disintegration of the USSR).
- 1991 - and on the present.

The middle of XVII century - have started to involve doctors for survey of alive persons and survey of corpses. The first written conclusions about a cause of death.

Peter I military and Sea charters (1716r.) - are legalised a forensic-medical examination and openings of corpses.

Since 1775 of the doctor are obliged to make openings.

The extremity of XVII century - have started to teach FM at universities.

1799 - the first textbook. Author I. Plenke (in I.G. Kashinsky's transfer)

1805 – departments of forensic medicine established in imperial Russian universities.

1835 – First domestic manual written by S.A. Gromov

1841 - N.I. Pirogov publishes the atlas for forensic physicians.

1842 - the first Charter of forensic medicine is confirmed.

1864 - occurrence of the St.-Petersburg, Moscow, Kiev, Kazan, Kharkov and Warsaw schools of forensic physicians.

1868 - the first congress of forensic physicians.

1924 - the first advanced training courses for specialists of forensic medicine established.

1909-1931 N.S. Bokarius heads department of forensic medicine in Kharkov and founded the Ukrainian scientific school for forensic experts.

The contribution of the Kharkov forensic physicians to science development

- In studying of grazes are engaged B.N. Zorin, V.I. Kononenko.
- Estimation of the time passed since death developed by prof. N. P. Marchenko.
- New methods of examinations and identification of human hairs created by prof. V.A. Tatarenko.
- Established first forensic spectral laboratory in Ukraine by N. M. Gubin, V.A. Tatarenko.
- Damage by sharp objects - S.P. Pribyleva.
- Forensic-medical classification of the blood traces created – L. V. Stanislavsky, G.L. Golobrodsky.
- Automobile trauma - V.M. Moiseyev.
- Motorcycle trauma - N.N. Tagaev.
- Railway trauma - L.A. Semenenko.
- Firearms trauma – U. A. Krapivkin, A.M. Gurov.

Chapter 2

PROCEDURAL REGULATIONS OF FORENSIC MEDICAL EXAMINATIONS

Forensic medical examination in Ukraine is carried according to Procedural criminal, civil codes and the «Law of forensic examination» from February, 25th, 1994.

The work medico-legal experts are guided by following instructive-methodological documents:

- The order №6 Health Ministry of Ukraine dated 17.01.95. Contains a regulation of rules of work of all departments and bureau FME units.

- Rules of work of the doctor-expert in the field of forensic medicine at external examination of a corpse on a place of its detection (incident).

FME should be made only by the person having the higher medical education (the forensic scientist, any doctor).

Forensic scientists are the doctors who have passed specialisation in FM and research assistants of scientific research institute, the professor, senior lecturers and teachers of courses and forensic medicine chairs consist in staff of bureau FME.

The rights of the expert

1. To get acquainted with the case materials and to make notes to draw a conclusion before the beginning of trials.
2. To declare a petition for granting additional materials to him or her, if such materials are necessary for drawing the conclusion.
3. To put questions to court, the defender, the accused, the witnesses.
4. To consult experts of all medical branches, with highly skilled experts.
5. With the sanction of the person making inquiry, the investigator, the public prosecutor or court, to be present during interrogation and other investigation actions and, in concern of the subject of examination, to put questions to persons being interrogated.
6. To receive compensation for expertise services, except for the those cases when these services are carried out according to the duty task.
7. If for judicial sitting several experts are invited, they have the right to confer with each other and produce one conclusion. If their opinions have not coincided, the doctors produce separate conclusions.
8. The expert, unlike the witness, stays in court room during the whole period of trials.

The Forensic Medical Expert is OBLIGED:

1. To be on call of the person making inquiry, the investigator, the public prosecutor, and court.
2. To draw the objective conclusion on the questions raised to him.
3. To carry out the expert research, present the conclusion in written form, and sign it.
4. If the question falls outside the limits of special knowledge of the expert or the materials given to him are insufficient for drawing the conclusion, the expert informs, in written form, the body that has assigned the examination on impossibility to draw the conclusion.
5. As the fiduciary, to keep the secret data of investigation or inquiry.

RESPONSIBILITY of the Forensic Medical Expert:

At assignment of examination, the expert carries the criminal liability in the following cases:

- Refusal of the expert to perform his or her duties (Article 385 of Criminal code);
- Disclosure of information in the period of pretrial investigation or inquiry (Article 387 of Criminal code);
- Knowingly false testimony (Article 384 of Criminal code).

The Medico-legal documentation

- «Medico-legal report».
- «Medical death certificate».

Medical Death Certificate

Once a doctor has decided that a person is dead, and then further action depends partly on the legal system of the particular country - and partly upon the nature of the death. Although wide variations in procedure exist between different states - and even sometimes between different parts of the same state - there are general principles, which are broadly similar. Usually, the doctor is required to issue a certificate of the medical cause of death, often called the Medical Death Certificate. An internationally standard system of certifying the cause of death has been adopted by almost all countries. The World Health Organization (WHO) recommends the following system.

The Medical Death Certificate is divided into two parts, the first (Part I) is the condition which leads directly to the death and the second (Part II) being other conditions, not related to Part I, but which also contributed to the death.

Part (I) is further divided into three subsections a), b) and c), which are causally related to one another, in that a) is due to b) which is due to c). Though only these three letters are printed on the death certificates, the doctor can add d), e), etc., if he so wishes, though it is unusual for this to be necessary.

It should be clearly understood that it is the last letter of Part (I) which is the primary pathological cause of death, and the one which is usually used for statistical purposes in compiling national and international mortality statistics, so it is important for the doctor to make sure that this lowest entry of Part (I) is the underlying pathological disease and not just a mode of death.

For example, a satisfactory Certificate might show:

- I. a) Acute anaemia of internal organs.
 b) Multiple fractures of ribs with injuries of lung tissue.
 c) Closed blunt trauma of the thorax.

- II. Coronary atherosclerosis.

Code: S 22.4.0

There is no need whatsoever to complete all three lines of Part (I), as long as the lowest entry gives the basic pathological disease.

It is unnecessary, though not incorrect, to include modes of death, even if the underlying cause is given, e.g.:

- I. a) Poisoning by ethyl alcohol,
 b) Toxic action of ethyl alcohol,
- II. Bronchopneumonia.

Code: T 51.0

The persons prescribing medico-legal examination

- Court.
- Employees of Office of Public Prosecutor.
- Ministry of Internal Affairs (polis inspectors).
- Commanders of military units.

Obligatory appointment medico-legal examination

Forensic-medical examination is necessarily in cases as stated below:

- Establishment of the causes of death;
- Establishment of gravity and character of the body injuries;
- Establishment of a sexual maturity of the victim (Sexual intercourse with a sexually immature person);
- Establishment of age (as referred to criminal liability);
- Mental condition (Forensic Psychiatric Examination).

Chapter 3

FORENSIC-MEDICAL THANATOLOGY

The medico-legal study of death falls within the unit of Forensic Thanatology (thanatos=death; logos=science). Thanatology deals with death in all its aspects.

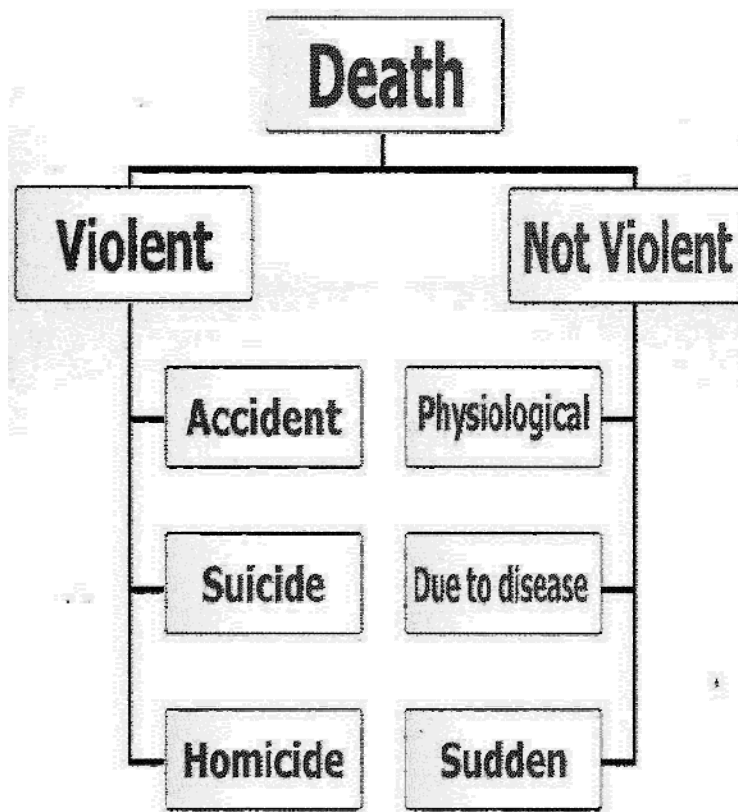


Fig. 3-1. Classification of death (V.V. Franchuk, 2011)⁷

Stages of the dyeing:

1. **Preagonal state.** There is a loss of consciousness, falling of arterial pressure, decrease of the level of metabolism.

2. **Terminal pause** (5-10 c. to 3-4 min.). Functioning of the nervous centres starts to have chaotic character; the arterial pressure and breath are reduced.

3. **Agony.** It is characterized by a further fall of arterial pressure and reduction of breath, but at a certain moment everything is back to normal and it seems that the person has survived the crisis and is recovering, but then all the parameters become again sharply reduced. The so-called "Hippocratic face" is observed (Hippocrates described the attributes of the dying person: sallow

complexion, loss of shine of the eyes, sticking of the eyes, lowering of the lower jaw).

4. **Clinical death** (5-6 min.). Complete oppression of consciousness, reflexes, heart activity and breath.

5. **Biological death.** It is the last stage of irreversible changes in organism.

Probable signs of death

- Cardiac standstill and respirations.
- Pulse disappearance on large arteries (carotid and femoral).
- Absence heart beating according to auscultation and an electrocardiogram.
- Disappearance of all functions and reactions CNS (absence of consciousness, spontaneous movements, reactions to all stimuluses, the maximum mydriasis).

Definition of biological death in outside of a medical institution.

- Present to apertures of a mouth and a fuzz nose.
- The equipment of a glass with water on a breast.
- Skin cut.
- Liquid ammonia present to a nose.
- Application of external stimuluses.
- Sign Beloglazov's («the cat's eye»).

Real sings of death

- Temperature of skin less than $+20^{\circ}\text{C}$.
- Temperature in a rectum less than $+23^{\circ}\text{C}$.
- Drying and loss of elasticity of skin.
- Livores mortis.
- Rigor mortis.
- Cooling of the body.
- Autolysis of inner organs.
- Putrefaction of body.
- Adipoceros formation or saponification.
- Mummification.
- Peat hardening.

*Table 3-1***Early and late postmortem changes (V.I. Akopov, 1998)¹**

Character of change of a corpse	Time of occurrence after death	Full development
Cooling of the body.	Hands and the face 1-2 hours Trunk 2-4 hours	24 hours
Drying of the body.	2-6 hours	Different terms
Livores mortis	Hypostasis 2-3 hours Stasis 12-24 hours	imbibition – more than 24 hours
Decomposition and decay		
Putrefaction	The extremity of the first 24 hours	Month and more
Preserving		
Mumification	The first month	3 and more months
Saponification		
Peat hardening	2-3 weeks and more are not established	6 and more months

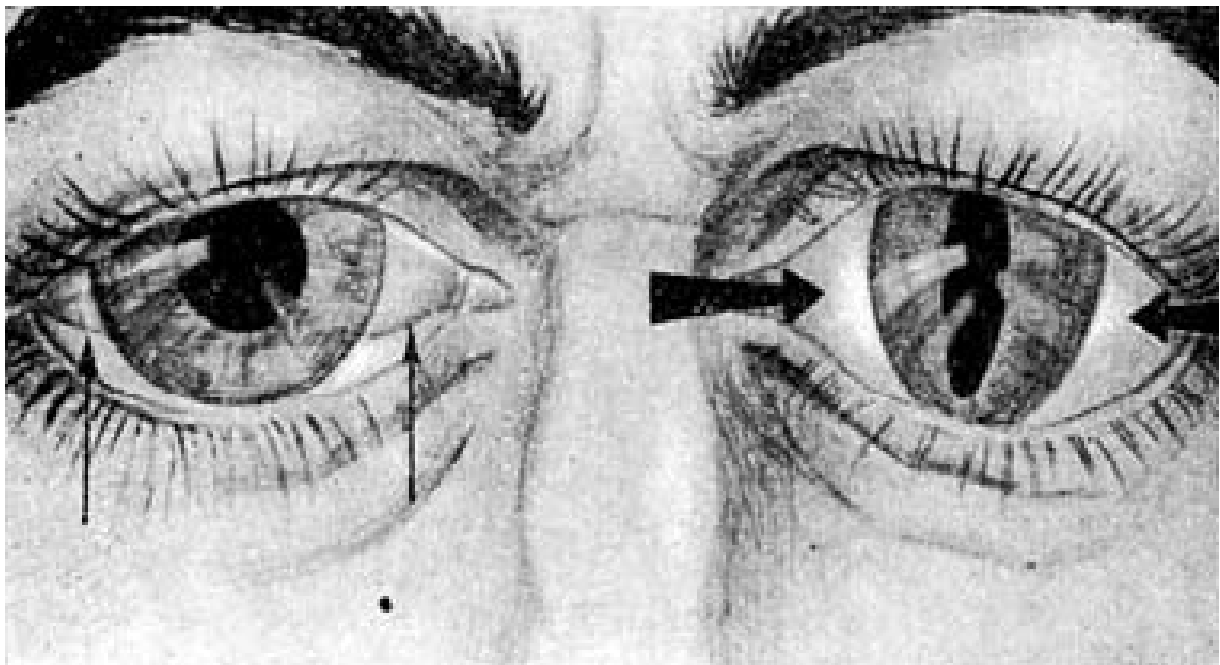


Fig. 3-2. Sign Beloglazov's (the left eye) and Larcher's spots (the right eye) (A.I. Muhanov, 2008)²



Fig. 3-3. Putrefactive bubbles
(S. Chand, 2023)¹¹

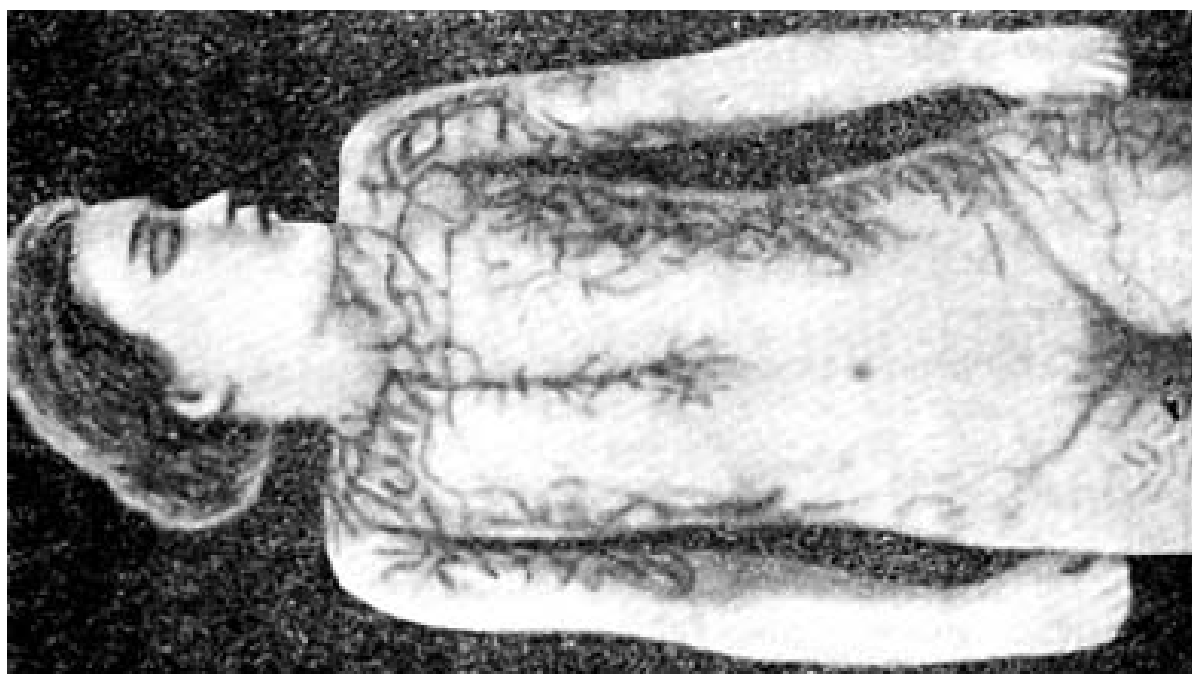
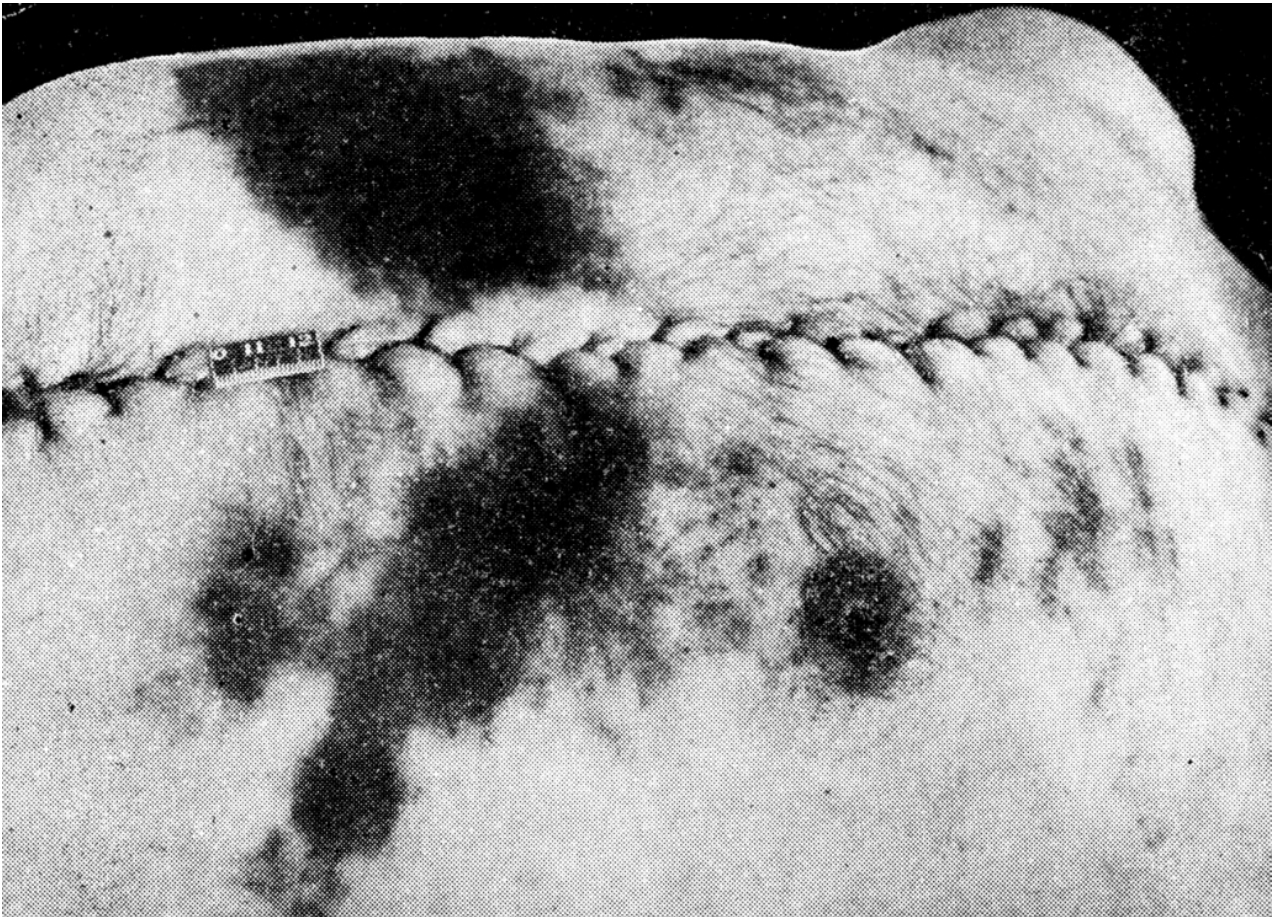


Fig. 3-4. A putrefactive net
(S. Chand, 2023)¹¹



*Fig. 3-5. Parchment spots with appeared through vessels
(A.I.Muhanov, 2008)²*

The putrefactive smell appears in 2-3 hours. By 15-24 hours it is already clearly notable.

Early postmortem signs

Cooling of the body

This is also known as Algor Mortis (Algor - coldness). Fall in temperature is one of the earliest sign of molecular death and may indicate the time since death. After death, heat production stops, the body loses heat by conduction, convection and radiation; and, temperature of the decedent falls until it is in equilibrium with the temperature of the surroundings. The rate of cooling of the body is depends on the age, conditions of the body, cause of death etc. In tropical climates, the heat loss is roughly 1.0°C to 0.7°C in an hour; and in temperate countries, it is roughly 1.0°C per hour.

Average heat loss is roughly 1 °C per hour and the body attains environmental temperature in about 16-20 hours after death.



*Fig. 3-6. A postmortem emphysema of a head
(A.I. Muhanov, 2008)²*

Estimation of time since death

Desiccation of the skin

After death, the skin becomes pale and ashy due to failure of peripheral circulation. It loses its translucency and elasticity. Some areas covered with thin epidermis (nose, lips, fingers, genitalia etc.) lose water and become dry. One of the kinds of desiccation is Larshe stains on the sclera. These are triangular spots formed on due to the cellular debris and drying of the cornea. Their appearance indicates time since death in 5-6 hours.

Rigor Mortis

Rigor Mortis begins in 2-4 hours after death in temperate countries, and 1-2 hours in tropic countries; primarily, in the mandibular muscles, later (4-8 hours after death) — in muscles of the neck, then the muscles of the trunk and upper extremities, and fully develops within 10-12 hours after death.

It persists in the body approximately 2-3 days and then disappears according to the same order (up to low). If the pose of the dead body is changed Rigor Mortis disappears in the moved parts and may be found later again, as soon as the action occurs. This may sometimes suggest a change of a body pose after death.

Postmortem lividity

Postmortem lividity (PML) begins as a series of mottled patches on the dependent parts of the body within about 1 -3 hours. These patches increase in size in 3-6 hours and the lividity is fully developed and fixed in about 6-12 hours.

The periods of PML development. There are 3 stages in PML formation: Hypostasis (1st); Stasis (2nd) and Imbibition (3rd). Hypostasis — is the earliest stage of PML and begins shortly after death. It may be visible in 1.5-2 hours after death and persists in the body for 8-10 hours. If the position of the body is changed during hypostasis, the pattern of lividity may be altered because of the ability of blood to flow easily from the distended capillaries. Thus, the PML in these cases disappears and new ones form on the dependent parts (laying on the back position-lividity on the back-turning of the body-lividity disappears on the back and forms on the anterior surface). The staining of the tissues is caused by the diffusion of hemoglobin. To check whether lividity has fixed or not, we apply thumb pressure. If the pressed area of PML disappears completely and returns to its previous color within 1-15 minutes, it means hypostasis, and death time cannot be more than 10-12 hours. Stasis. In about 10-12 hours blood coagulation occurs and Livores mortis becomes fixed. If the position of the body is changed during this period, the pattern of PML is not altered. Under thumb pressure, the staining area blanches only and returns to its previous color within 0.5-1 hour. Duration of stasis is 10,12-24, sometimes 36 hours. Imbibition. It takes place when no less than 24-36 hours have elapsed since death. Lividity is completely fixed; therefore, it doesn't change its color by thumb pressure.

Late postmortem signs

Mummification

Mummification is a modification of the putrefaction in which there is dehydration or total dessication of the body. The skin becomes dry, shrunken, leathery and rusty brown. The body is odorless. The soft parts shrivel up, but retain their natural appearances and features. Internal organs become a dried mass. Free circulation of air, high temperature and the absence of moisture are

the main factors affecting mummification. Required time for mummification is around 2-3 months (in the conditions mentioned above).

PUTREFACTION

Features	Time of appearance
1. Bad Smell	20-30 hours
2. Green color at the right iliac fossa	2-3 days
3. Postmortem vomit	3-5 days
4. Putrefactive venous net	3-5 days
5. Discoloration of whole abdomen	4-5 days
6. Cadaveric emphysema	5-7 days
7. Discoloration of whole body	12-14 days
8. Postmortem bubbles	1,5-2 weeks
9. "Gigantic" body	2-3 weeks
10. "Spumous" organs	3-4 weeks

Fig. 3-7. Signs of putrefaction (V.V. Franchuk, 2011)⁷

Saponification (Adipocere formation)

It is a modification of the putrefactive process in which the fatty tissues of the body are hydrolyzed into fatty acids. Adipocere (adipis > soft fat, cera > wax). Saponification is usually first seen in bone marrow and the subcutaneous fat of cheeks, breasts, buttocks and abdomen. It is a yellowish white, greasy wax-like substance with a rancid smell. Its density is less than water, that's why adipocere floats on water. It is composed of saturated fatty acids (stearic, palmitic), calcium soaps, proteins etc. and in result from hydrogenation of unsaturated body fats into firmer fats and their hydrolysis into fatty acids. It cuts easily and burns with a faint yellow flame. The time required for adipocere formation is around 8-10 months (for the Ukrainian climate).

Chapter 4

FORENSIC TRAUMATOLOGY

Wound (legal definition): breach of the full thickness of the skin (or lip lining of). This excludes abrasions, bruises, internal injuries, and fractures.

Wound (medical definition): disruption of the anatomical continuity of the tissues produced by external mechanical force.

Injury: from the Latin "injuria" (in - not, jus - the law). The term is often used synonymously with wound but can have a wider use, including damage to tissues by heat, cold, chemicals, electricity, radiation, in addition to mechanical force.

Lesion : from the Latin "laesio" (a hurt). Originally meant injury, now more widely applied to include "any area of injury, disease, or local degeneration in a tissue causing a change in its function or structure".

Trauma: bodily harm with or without structural alterations resulting from interaction with physicochemical agents, imparting energy to tissues.

May cause morphologically apparent damage (wound) or produce physiological imbalance (e.g., reflex cardiac arrest by neural stimulation) and second-ary effects (e.g., thrombosis, infection, obstruction of tubular organs).

CLASSIFICATION OF INJURIES ACCORDING TO CAUSATIVE FACTORS:

I. Mechanical or Physical injuries. These are the injuries produced by application of mechanical force. These are:

Injuries produced by application of blunt force:

1. Abrasion;
2. Bruise or contusion;
3. Laceration;
4. Fracture or dislocation of a bone, tooth, or joint.

Injuries produced by application of sharp edge and pointed end of a weapon:

5. Incised wound;
6. Punctured (stab) wound;
7. Incised-stab wound;
8. Chopped wound;
9. Sawn wound.

Injuries caused by a high velocity projectile:

10. Firearm wound.

II. Thermal injuries.

1. Due to application of heat

a) General effects of exposure to heat, hot atmosphere (may not cause any visible injury):

Heat hyperpyrexia (heat stroke or sun stroke).

b) Effects of local application of heat:

Burn (due to application of dry heat);

- Scald (due to application of moist heat).

2. Due to application of cold.

a) General effect of exposure to cold:

- Hypothermia.

b) Local effects of exposure to cold:

- Frost bite (due to dry cold);

- Trench foot (due to moist cold).

III. Chemical injuries: Corrosive poisons. IV. Miscellaneous injuries:

1. Electrical injury (due to electrocution).

2. Radiation injuries (due to X-ray, radio-active substances).

3. Lightning injuries (a combination of electrical injury, mechanical injury and thermal/burn injury).

4. Blast injuries (a combination of mechanical and thermal injuries).

SCHEME OF DESCRIPTIONS OF INJURIES

1. Localization. At definition of localization of damage it is necessary to specify anatomic area of a body in which it is located (for example, in the field of a forehead, on a forward surface of a thorax, on a stomach, etc.), and then to detail an arrangement (under condition of vertical position of a body).

2. A kind of injury (graze, a scratch, bruise, a wound, etc.).

3. The shape of injury.

4. The sizes of injury.

5. Direction of the length of injury.

6. Color.

7. Character of edges and the ends of a wound.

8. A condition of surrounding tissues.

9. Interposition of damages.

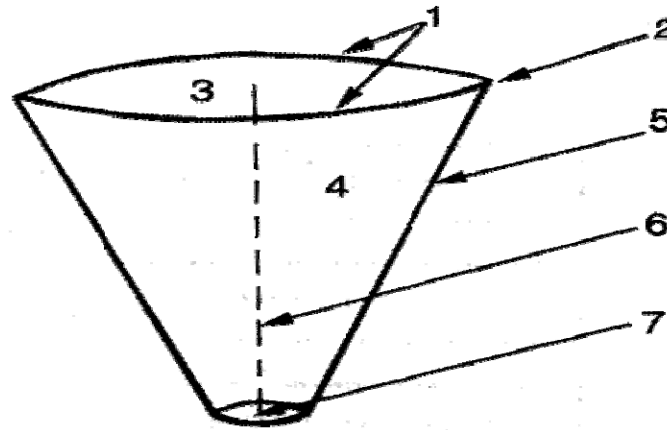


Fig. 4-1. *Wound Components (N. N. Tagaev, 2003)³:*
 1 – edges; 2 – ends; 3 - wound lumen; 4 - wall of the channel of a wound;
 5 - rib of the channel of a wound; 6 - channel of a wound;
 7 - Bottom of channel of a wound

THE DAMAGES FORMED FROM INFLUENCE OF BLUNT OBJECTS

The tool of a trauma which does not have the sharp ends and edges is called as blunt

The mechanism of damaging action of blunt firm objects.

Impact. Is a short-term process at which arise, as a rule, damages to a zone of direct influence of force. If impact is directed along an axis of a body (for example, falling from height on feet), damages can be formed on significant removal from a place of application of force.

Pressing. It is necessary to consider, that during pressing on a body simultaneously not less than two objects act. Thus force of action of objects is directed towards each other and more often one of objects in this case is in movement, and another - is rather motionless (pressing at crossing by a wheel of the car, at pressing by a board of a body to a wall, etc.).

Stretching. It is important to know, that the stretching is characterized by long action on a body of two forces missing in an opposite direction. Often in practice such action is rendered with rotating mechanisms of machine tools, machine tools of moving vehicles. At a stretching there are lacerations, removing parts of a body, etc.

Friction. Characteristic thing of the friction is an mutual displacement under the attitude to each other damaging object and a part of a body therefore

there is their superficial contact is characteristic and arise abrasions of the various area.

Combined type. Combination of several mechanisms of action.

CLASSIFICATION OF BLUNT FIRM OBJECTS:

1. Parts of a body of the person (fingers, a fist, a palm, a leg, a teeth, other parts of a body) with which it is possible to cause damages.

2. Objects which the person can take in hands and cause damages. These instruments depending on the form of an operating surface in turn are subdivided into objects: a) with a flat striking surface; b) with rounded off (cylindrical, spherical);

c) with rough; d) with angular edge (two-sided, many-sided).

3. Larger objects (parts of moving mechanisms, vehicles, animals, etc.).

4. Part of a body of the animal (hoofs, horns, etc.).

Except for such given classification blunt objects should be differentiated on the area beaten objects: if the sizes of a striking surface there is more than body of the person (for example, asphalt covering on which there was a falling from height) it name “unlimited”. Limited striking surface name in the event that its sizes do not exceed the area of impact (a fist, a hammer, stone, etc.).

Thus it's necessary to take into memory, that the form of a striking surface in some separate cases can be displayed in damage owing to what it can be defined without presence of a object.

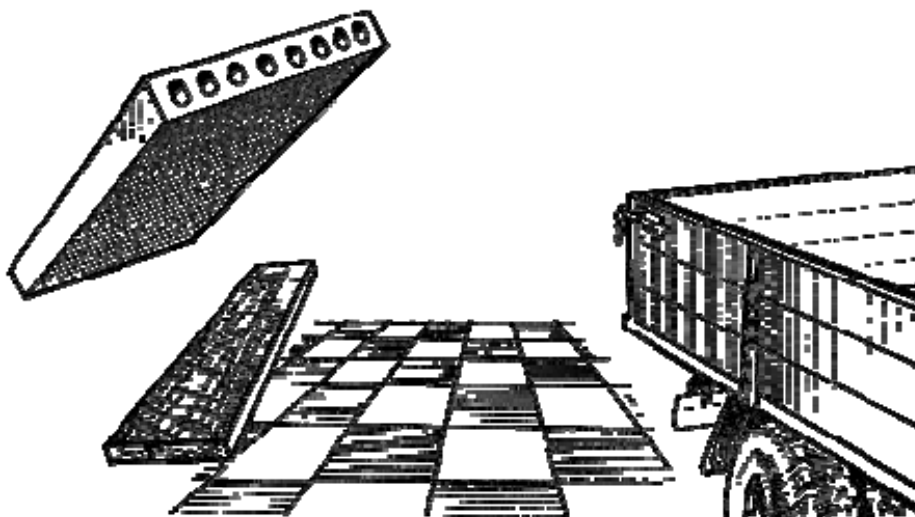


Fig. 4-2. Blunt objects with a flat prevailing surface

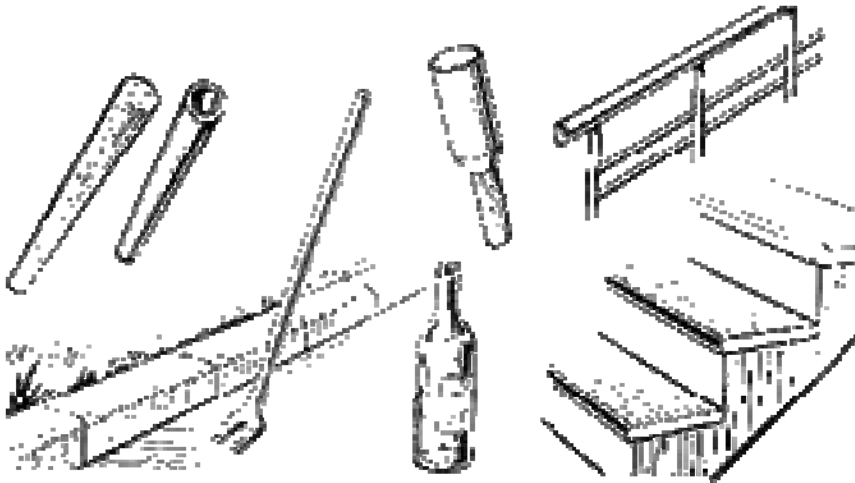


Fig. 4-3. Blunt objects with a cylindrical surface

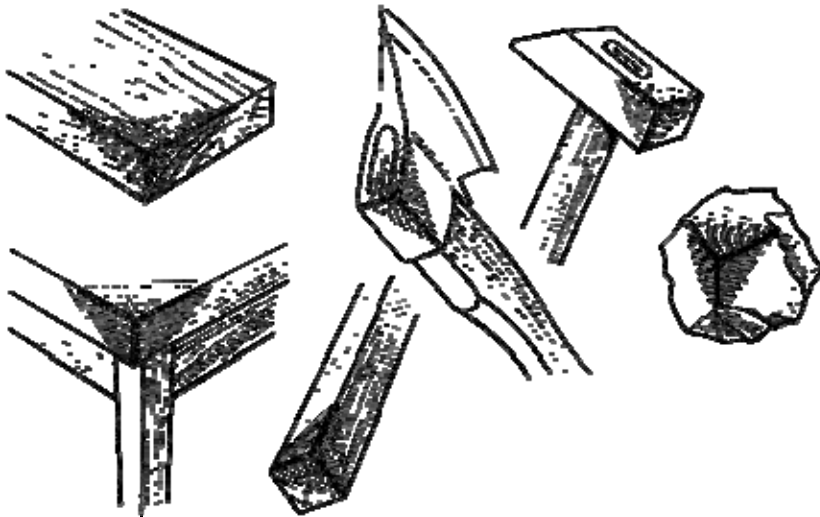


Fig. 4-4. Blunt objects with a trihedral angle

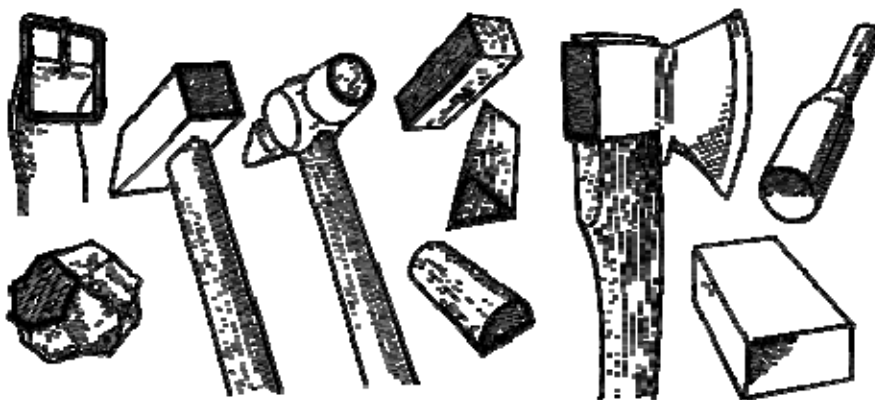


Fig. 4-5. Blunt objects with the flat limited surface

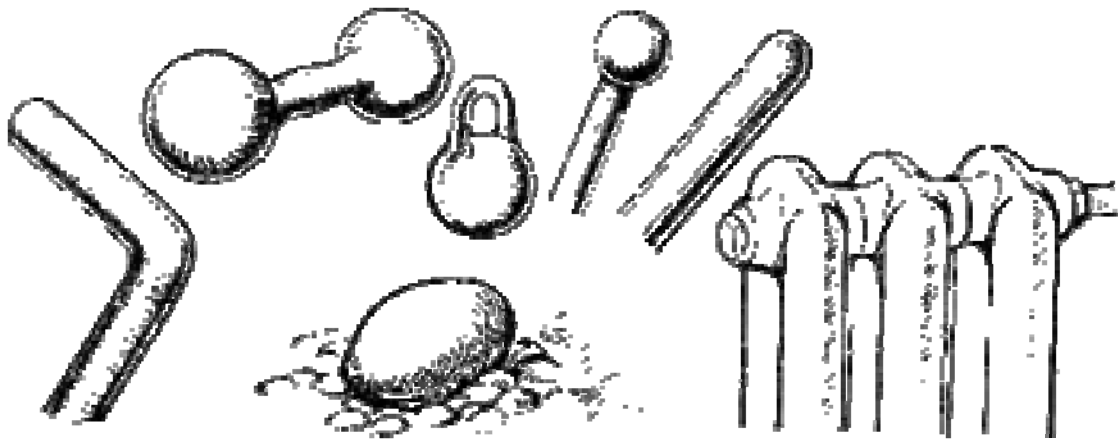


Fig. 4-6. Blunt objects with a spherical surface

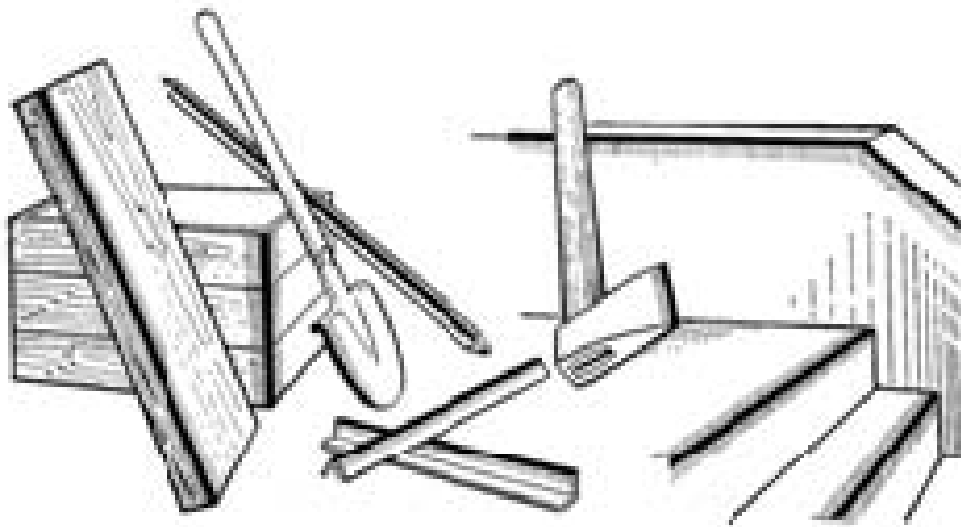


Fig. 4-7. Blunt objects with a two-sided angle

Abrasions

Abrasions - mechanical damages of superficial layers of a skin (epidermis) or epithelial layers of mucous membranes. The abrasion arises owing to movement of an injuring object, on the surface of bodies (at movement of a body in a object) or as a result of mutual sliding and insignificant pressing them to each other during what there is a friction and are removed superficial layers of a skin.

Abrasions are of four types.

1) Scratches are caused by edges object passing across the skin, such as a fingernails.

2) Grazes (sliding, scraping, or grinding abrasions) are the most common type.

3) Pressure Abrasions (crushing or friction abrasions) are caused by crushing of the superficial layers of the epidermis and associated with a bruise of the surrounding area.

4) Impact Abrasions (contact or imprint abrasions) are caused by impact with a rough object, when the force is applied at or near a right angle to the skin surface, such as when a person is knocked down by a motor car. In such cases, the pattern of the radiator grill, headlamp rim, or the tread of a tyre may be seen on the skin.

The **size** of abrasions can be various, that depends on the area (sizes) of a part of an operating object contacting to a body, and also from length of a way of its movement on a body.

The **shape** of abrasion quite often repeats in the certain shape of a contacting object, therefore it needs to be described most carefully in the expert document or to photograph.

White flakes of epidermis on the surface of the abrasion can determine about direction of the blunt object, which are sometimes visible and with opened eye, but more often for their detection resort to survey of an abrasion by means of a good glass stereomicroscope. Quite often in a final part of an abrasion more expressed pollution can be found and owing to hit of the particles which are available on a surface of a object, including pollution due to removing the basis of a moved object if it was fragile.

It is necessary to consider, that on appearance it is possible to establish also time of occurrence of abrasion. It is known, that abrasions heal with formation of a crust after which tearing away scar it is not formed.

During healing abrasions it is possible to allocate 4 stages which definition allows to solve the problem on prescription of an origin:

1) up to 12 hours: the surface of an abrasion is below a level of a surrounding skin, in the beginning an abrasion wet, pale, then reddens a little and dries up;

2) till 24-48 hours: the dried up surface gets brownish painting and is leveled with a surface of a surrounding skin owing to occurrence of a crust;

3) from 48 up to 96 hours: the crust rises above a surface of a surrounding leather and by the end of this period starts to exfoliate on periphery;

4) from 96 hours till 7-12 days: the period of full tearing away of a scab and occurrence on its place in the beginning pink, and then painting turning pale and not differing a surrounding skin (the trace on a place of a former abrasion sometimes can be found even out through 30 and more days).

Medico-legal Importance

- 1) They give an idea about the site of impact and direction of the force.
- 2) They may be the only external sign of a serious internal injury.
- 3) Patterned abrasions are helpful in relating the wounds to the object that produced them.
- 4) The age of the injury can be determined.
- 5) In open wounds, dirt, dust, grease or particles of stone or sand are usually present, which may relate the injuries to the Scene of crime.
- 6) Character and manner of injury may be known from its distribution:
 - In throttling, crescentic abrasions due to fingernails are found on the neck.
 - In smothering abrasions may be seen around the mouth and nose.
 - In sexual assault, abrasions may be found on the breasts, genitals, inside of the thighs and around the anus.
 - Abrasions on the face or body of the assailant indicate a struggle.
 - Abrasions on the victim's body may show whether the fingernails of the assailant were long, irregular, or broken.

Bruises

Bruises are the hypodermic haemorrhages arising from influences of blunt objects owing to break fine arteries or veins. In the sizes bruises are different - from spots up to extensive, locating at the greater area of a body. They can extend on hypodermic subcutaneous fat, between fascies to spaces on the sites which are being near from direct influence of force and consequently specify not a site, and on area of its application.

Age of Bruise

Color and intensity of painting fresh bruises depend both on volume of the grown lazy blood, and from thickness of those tissues, under which this blood settles down. Fresh bruises can be reddish, bluish, dark blue, brownish and others colors. In particular, they have reddish color on sites thin skin, on mucous. It is necessary to remember also, that painting bruises can be shown not at once, and later a little hours after their formation that is connected with promotion of the grown lazy blood to a surface of a leather. It is known, that painting bruises changes in due course communications with the certain transformations of hemoglobin. Initial color passes in greenish, that is connected with transformation of bilirubin in biliverdin. Greenish painting, as the rule, appears in the beginning on periphery of bruise, and then extends

further on its surface. Green painting is replaced yellow, that is connected with transformation of biliverdin in haemosiderin. However in practice "blossom" of the bruise can press and in another way. Not seldom in a zone of bruise doctor observes connection in the beginning yellow (instead of green) painting which then is replaced green. It is necessary to distinguish bruises during of their occurrence:

- a) fresh** (in their zone only the first painting)-up to 3 days;
- b) non fresh** (green or yellow painting joins)-up to 6-7 days;
- c) old** (traces of 1-st, 2-nd, 3-rd painting)-more than 8 days.

Medico-legal Importance

1. The degree of violence may be inferred from the damage size.
2. Patterned bruises may show relation between the victim and the object or weapon, e.g., whips, chains, canes, ligature, vehicle, etc.
3. Prescription of injury can be determined.
4. Character and manner of injury may be known from its distribution:
 - a) If the body was grasped with the assailant's arms, there may be 3 or 4 bruises on one side and one larger bruise on the opposite side of the body, produced by the fingers and the thumb respectively, which indicates the position of the assailant being in front of or behind the victim.
 - b) Bruising of the victim's arms may indicate restraint.
 - c) Bruising of the shoulder blades indicates firm pressure on the body against the ground or other resisting surface.
 - d) In manual strangulation, the position and number of bruises and nail marks may give an indication of the method of attack or the position of the assailant.
 - e) Bruising of the thigh, especially of its inner aspect, and of genitalia can be indicative of rape.

Wounds

Wounds - is mechanical damage to the skin or mucous membranes at full depth or deeper.

Wounds heal with scar formation (secondary tension for blunt objects). The wounds usually occur in areas where a thin layer of soft tissue and are located close to the bone.

Types of wounds: split lacerations, avulsion, stretch lacerations, and cut laceration. Different shapes of wounds are presented on Fig. 4-8-18 (A. I. Muhanov, 2008).

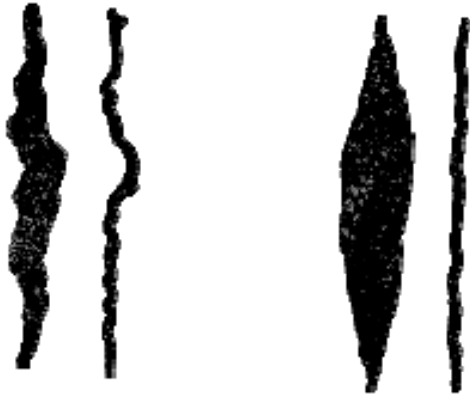


Fig. 4-8. Fissural shape of the wound



Fig. 4-9. Crescent-shaped wound



Fig. 4-10. The zig-zag shape of the wound



Fig. 4-11. The rectangular shape of wound

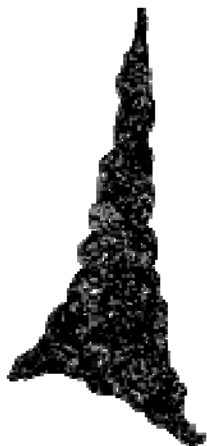


Fig. 4-12. The triangular shape of wound



Fig. 4-13. The linear form of wound



Fig. 4-14. *The trapezoidal shape of wound*

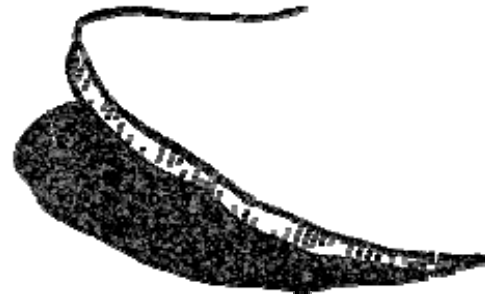


Fig. 4-15. *Patchwork shape of wound*



Fig. 4-16. *Branched shape of the wound*



Fig. 4-17. *The indefinite shape of wounds*



Fig. 4-18. *Radiant (T-, T-, Y-, X-shaped, etc.) shape of wound*

Table 4-1

Signs of wounds inflicted by blunt objects

The name of signs	
Edges of wounds	Non straight
Tissue crosspieces(tags)	Present
Grazes and bruises in a circle	Present
Bulbs of hair	Pulled out
Bleeding	Small
Healing	Secondary tension
Gaping wound	It is poorly expressed
Opening in wound	May be not clear

General features of wounds**For objects with a unlimited flat surface typically:**

- Zigzag, branched wounds.
- Significant grazes.
- A large area.
- Crush injury.
- Patchwork torn margins.

For objects with a flat limited surface is typically:

- Radiant wounds.
- grazes at the edges of wounds in some cases completely or partly reflect a form of traumatic surface.

For objects with a spherical surface is typically:

Radiant wounds.

- The central part of the wounds, saucer-shaped deepened.
- The edges of them smashed, thinned.
- In the center is often detected defect triangular or rectangular shape.
- The edges of the wound grazed as a circle or ring.



Fig 4-19. The wound of the occipital region of the action prevailing surface – falling from a height of 3 m edges of the wound significantly grazed (A .I. Mukhanov, 1988) ²

For objects with a cylindrical surface is typically:

- fissural-shaped, crescent-shaped wound.
- often there are two parallel perpendicular breaks with a jumper.
- length of wound parallel to the axis of the object.
- The edges of the wound are uneven, winding, thinned to the center.

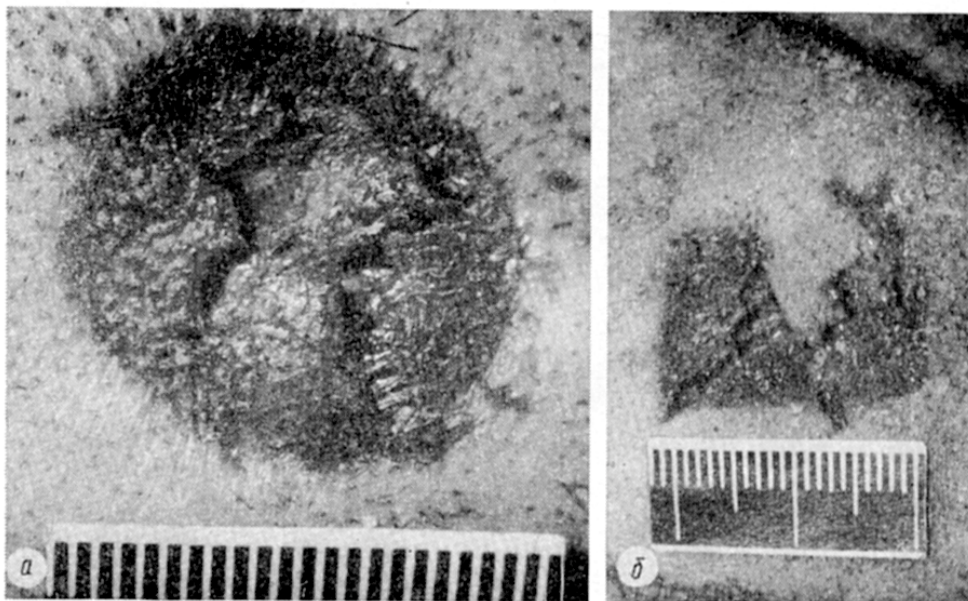


Fig. 4-20. The wounds inflicted by object with limited surface:
a, H-shaped wound caused by round hammer blow, graze wounds around the site of impact, and b-X-shaped wound from square hitting surface with graze wounds, in shape to hit objects (A. I. Mukhanov, 2008) ²

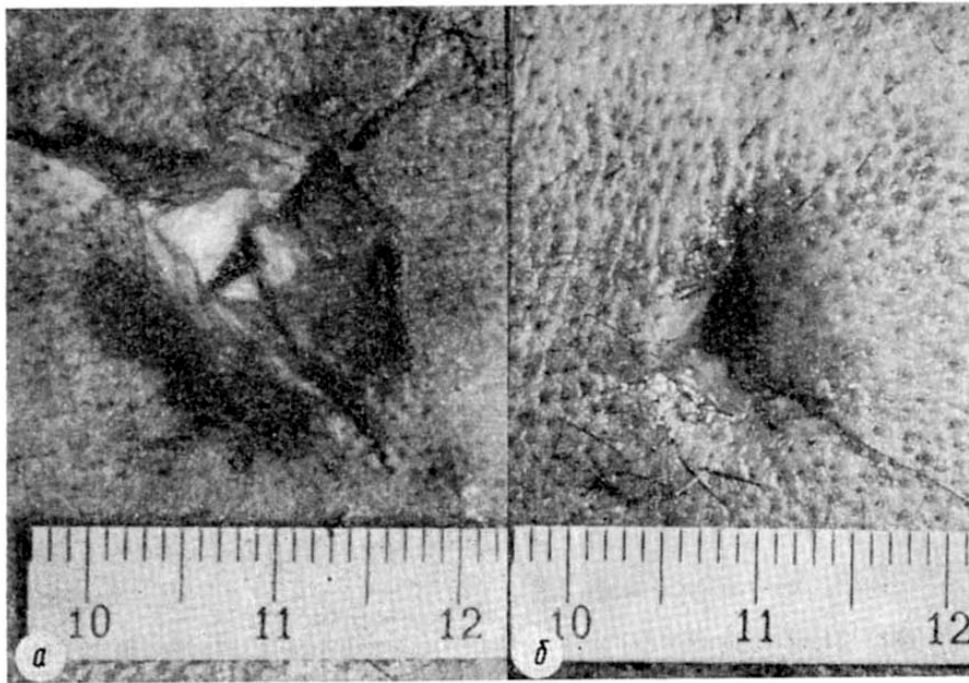


Fig. 4-21. Wounds inflicted by objects with a spherical surface with a defective tissue in the heart: *a* grazes wound; *b* funnel-recess in the central part of the wound (A.I. Mukhanov, 2008)²

For objects with an edge (in the form of a two face angle) is typically:

- fissural-shaped wounds.
- the edges are uneven, grazed.
- ends of wounds with sharp angles, with the tissue webs at their ends.



Fig.4-22. Fissural-like wounds in the occipital-parietal region, caused by a cylindrical metal rod (A. I. Mukhanov, 2008)²



Fig. 4-23. X-shaped wound that resulted from a single impact by object with cylindrical surface (A. I. Mukhanov, 2008) ²

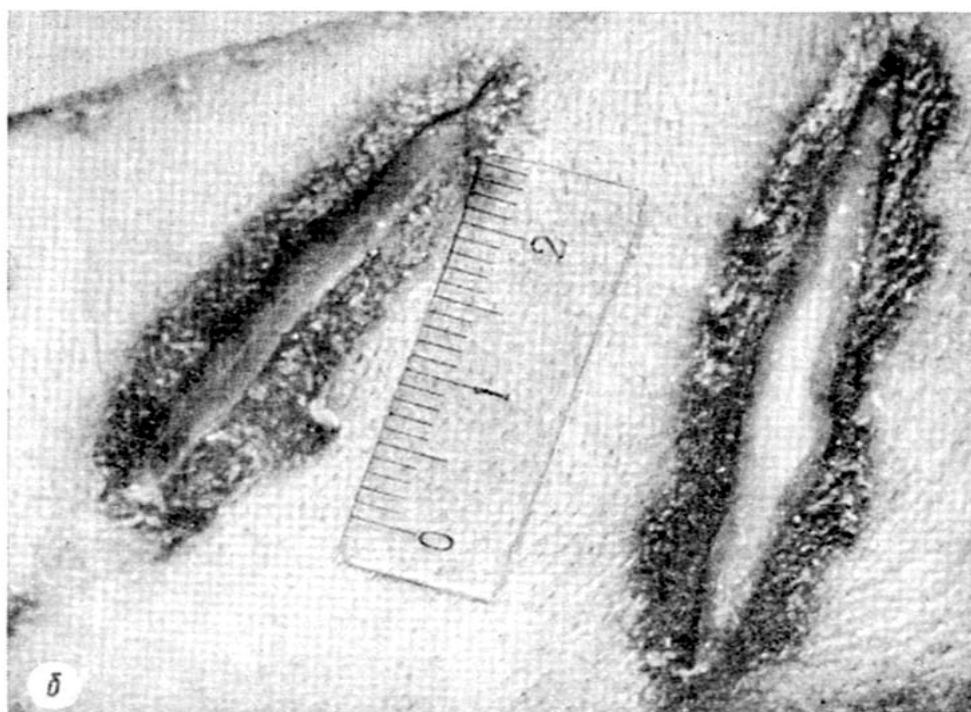


Fig 4-24. Fissural-like wounds caused by object with expressed edge (A. I. Mukhanov, 2008) ²

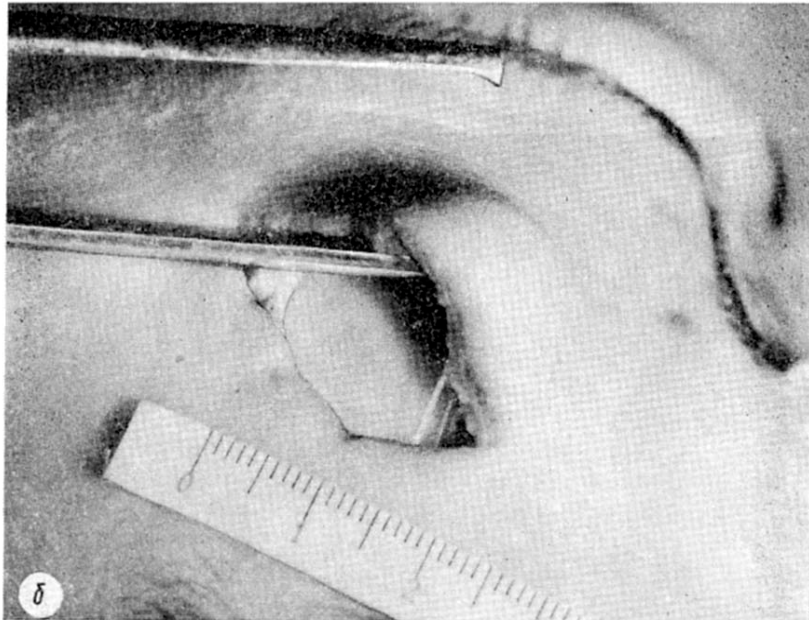


Fig 4-25. Fissural wound at the middle of the forehead with a relatively smooth, almost graze and bruises edges, caused by a blunt object with a rib during transport trauma. (A.I Mukhanow, 2008) ²

For objects with a triangular angle typical:

- Wounds with three rays.
- Center for wounds deepened.
- The edges of the wound graze.
- At the ends of the gap, presence dry spots.



Fig. 4-26. Triradial wound parietal-occipital region, caused by a blunt object with a triangular angle (A.I. Mukhanov, 2008) ²

Medico-legal Importance

- 1) The type of laceration may indicate the cause of the injury and the shape of the blunt weapon.
- 2) Foreign bodies found in the wound may indicate the circumstances in which the crime has been committed.
- 3) The age of the injury can be determined.

Fractures

A fracture is defined as a break in the continuity of a bone. If the break is due to trauma, it is known as a traumatic fracture.

Fractures may result from direct violence such as blows or indirect violence such as falls, or the action of muscles. While fractures have special characteristics and fall within the domain of surgery and orthopaedics, a certain number of cases require special consideration from a forensic medical point of view.

A fracture caused by a direct violence can be judged from its position and the presence of a bruise or wound of the skin in the area of fracture. In some cases, however, no bruise or wound may be found but such a fracture is usually transverse and sometimes comminuted.

When the fracture is due to indirect violence, such as a fall, the fracture occurs at the weakest part of the bone, is usually spiral or oblique, and may not be accompanied by a bruise or a wound.

Fractures showing multiple breaks are known as comminuted fractures.

If the skin above the fracture is intact, the fracture is known as a closed (simple) fracture. If the skin above it is lacerated, the fracture is known as an open (compound) fracture because it communicates with the outside air and is open to infection.

Fractures of the Skull

Direct (local) fractures of bones of a skull conditionally subdivide on foraminous, pressed and step-shaped, though step-shaped fractures can be considered as a version pressed. Such classification of fractures is based on force, a direction of influence and character of an injuring surface of a blunt firm object. At influence of the same objects with various force foraminous fractures can be generated in one case pressed, and in other case, and an obligatory condition of formation of foraminous fractures is presence of the limited injuring surface by the area no more than 16 cm². On a place of influence of such object the defect corresponding the sizes and the form of the injuring surface of a blunt firm object by which blow is striked is formed.

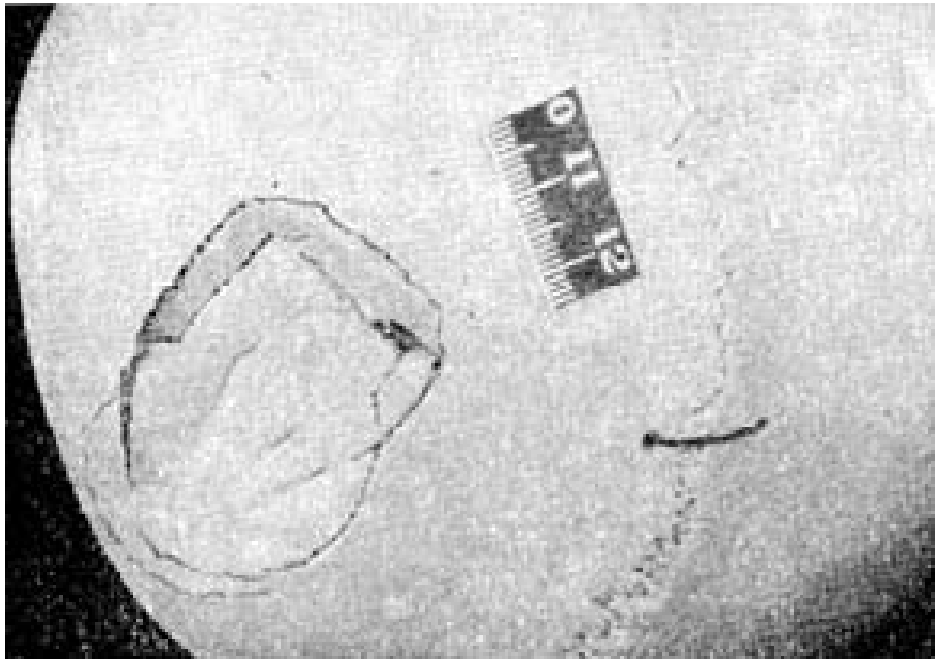
Foraminous fractures are more often formed from influence of the limited flat surface and less often from a spherical, trihedral and cylindrical surface.

The pressed fractures are formed more often from impacts spherical, cylindrical, trihedral and dihedral angular surfaces. At slanting impacts (under a corner to a damaged bone), as a result of non-uniform influence of the limited surface, arise terraced shaped fractures in which fragments are located in the form of the steps-terraces leading to a place of influence of a side of a object. At action spherical and angular surfaces of a terrace can be formed and on edges of foraminous fractures.

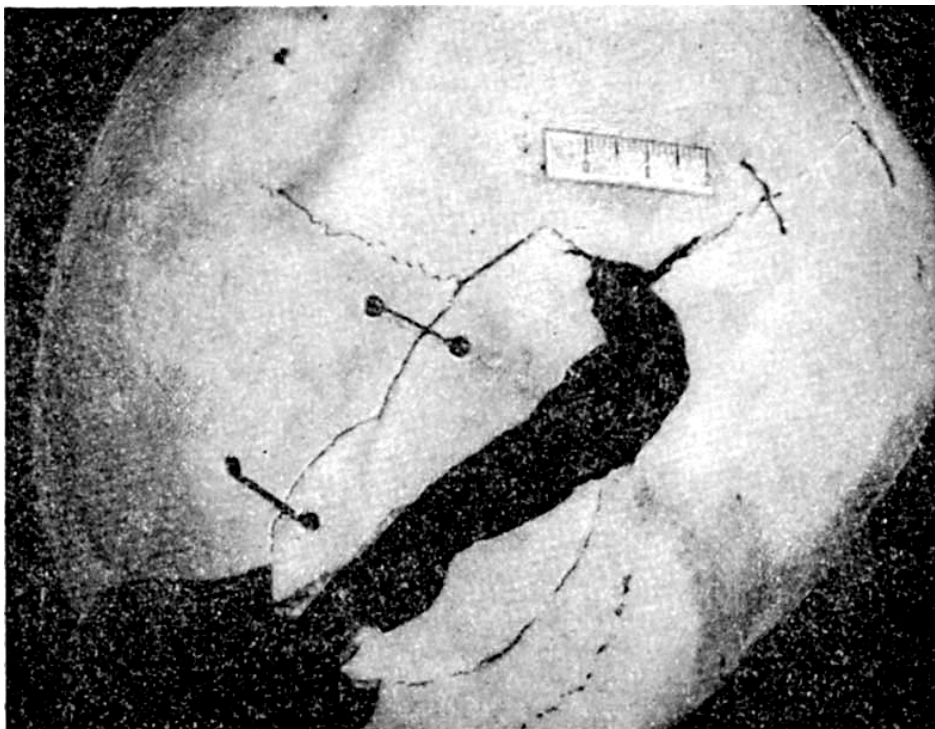
The indirect (remote) fractures concern to constructional destructions of a complex of bones of a skull, these damages appear on the certain extent from a point of application of force (or impact) they are extensive and are accompanied by formation of large fragments and splinters of a bone. Such fractures, as a rule, are formed owing to impacts by a massive blunt firm object with a prevailing “unlimited” flat surface (or at falling on those, for example (at falling from height on asphalt) or at pressing of skull between blunt objects (for example at crossing wheels of the car). These kinds of influences cause the general deformation of a skull, which can be considered approximately as sphere.



Fig 4-27. Direct fracture of the lower part of the right parietal bone from the impact with the subject of the round is limited space - a hammer (A. I. Mukhanov, 2008)².



*Fig. 4-28. Frontal bone fracture due to shock ax
(A. I. Mukhanov, 2008) ²*



*Fig. 4-29. Oblong fracture of the skull caused by a blow from a fence rail
(A. I. Mukhanov, 2008) ²*

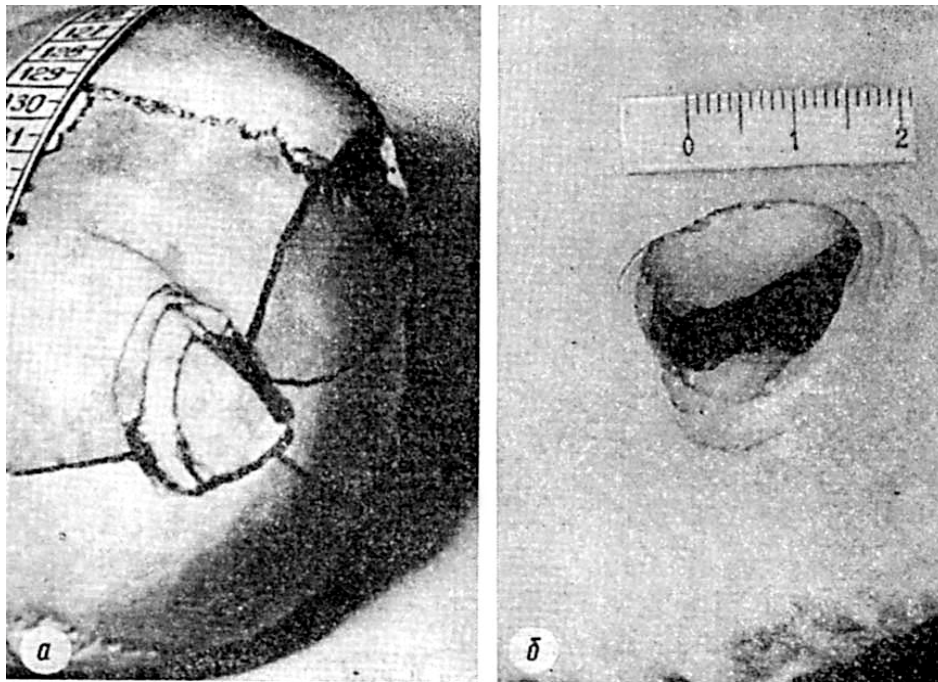


Fig. 4-30. Step-shaped fractures of the parietal bone
(A.I. Mukhanov, 2008) ²

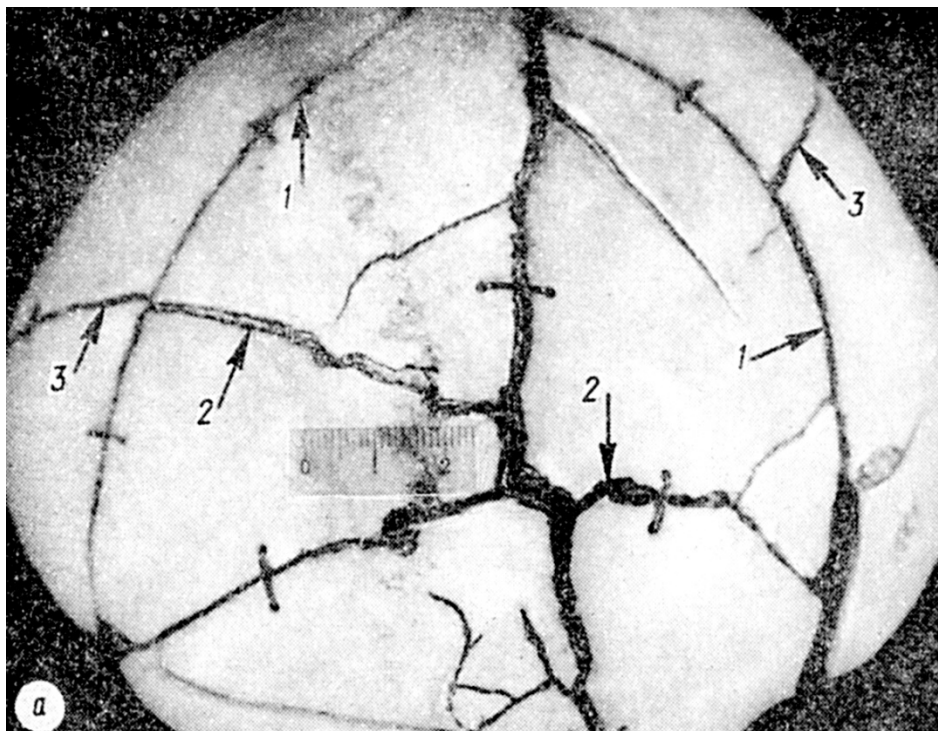


Fig. 4-31. Comminuted fracture of the skull caused by the impact of the dominant surface in the accident: 1 - arc-shaped crack along the border areas of deformation 2 - radial cracks from the center area of deformation, 3 - remote, extended fractures (A.I. Mukhanov, 2008) ²

DAMAGES CAUSED BY SHARP OBJECTS

The sharp instrument influences a body of the person the sharp end or edge which in forensic medicine name "spike", "edge" and "blade". Depending on design features, and also the mechanism of their influence on damaged surface, all sharp instruments divided on stabbing, cutting, stabbing-cutting, chopping and sawing. These objects in the majority are instruments as they are made for application in a life or on manufacture (sewed, a kitchen knife, an axe, saw, etc.).

Sharp instruments (objects or the weapon) cause mainly such injuries as wounds, and also little cuts and scratches. Cuts name superficial injuries of a skin and internal bodies, scratches – linear abrasions. Attributes the wounds formed from influence of sharp instruments, are: linear character, equal smooth edges, more often without additional damages, absence of tissue fibres. It is necessary to remember, that the same sharp object, for example a knife like combined tool, can carry out cutting and stab-cutting functions.

Table 4-2

Signs of wounds inflicted by sharp objects

The name of signs	
Edges of wounds	Straight
Tissue crosspieces (tags)	Absent
Grazes and bruises in a circle	Absent
Bulbs of hair	Hair was entangled
Bleeding	Strong
Healing	Initial
Gaping wound	May be
Opening in wound	Clear and considerable

Wounds

Stab wounds

Stab wounds are formed from action stabbing objects which are subdivided on conic, cylindrical and pyramidal, for example: awl, needle, a nail, a tetrahedral bayonet. These objects, damaging a skin, operate mainly the spike, and in process of immersing in thickness of a tissue and by the lateral surfaces, sides and edges.

At immersing a stabbing object it moves apart tissues, causing such way wounds. At sliding an edge on a skin abrasion are formed.

Shape of stab wounds on a skin basically depends on the form of cross-section of a used stabbing object

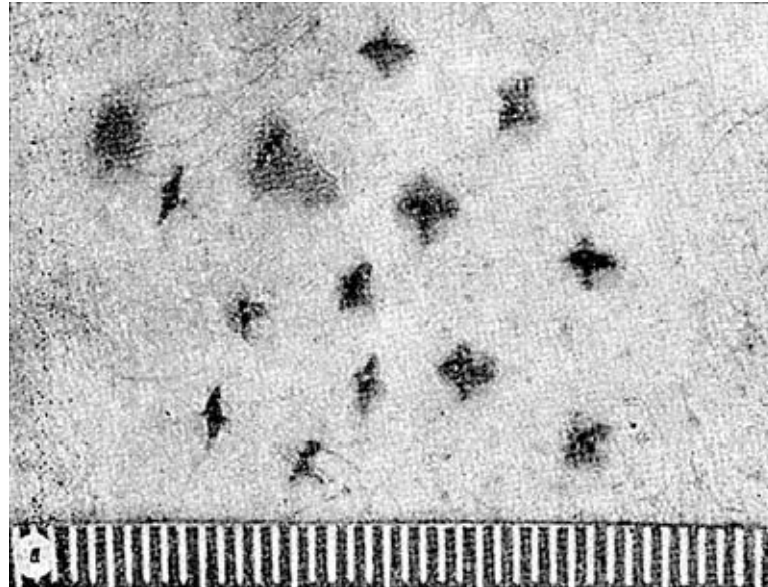


Fig. 4-32. Cross-shaped wounds, caused by sharps with object with four edges (square cross section). The edges of some wounds dried (K.Tamilmani, 2021) ⁴

Edges such wounds are represented equal, under condition of perpendicular action of the stabbing instrument, they have in regular intervals expressed of band of abrasion. In cases of influence of such object under a angle an abrasion can be with unequal width.

For stab-wounds an external bleeding is not typical. For such injuries damage of internal bodies with a plentiful internal bleeding is typical.

Depth of stab wounds always prevails over their external size.

Medico-Legal Importance of Stab Wounds

- The shape of the wound may indicate the type of the weapon that may have caused the injury.
- If a broken fragment of the weapon is found, it may identify the weapon or connect the accused person with the crime.
- The depth of the wound indicates the force of penetration.
- The direction and dimensions of the wound indicate the relative positions of the assailant and the victim.
- The age of the injury can be determined.
- Position, number, and direction of the wounds may indicate the type of injuring, i.e., suicidal, accidental, or homicidal.

Complications

1) Internal haemorrhage is larger than the external haemorrhage due to injury of the internal vessels.

2) Injury to the vital internal organs is more common and is a real danger.

3) The wound may become infected.

4) Air embolism may occur in a stab wound of the neck if it penetrates through the jugular vein.

5) Pneumothorax.

6) Asphyxia due to inhalation of blood.

Incised wounds

Incised wounds are formed from sharp edges of cutting objects.

A characteristic example of the cutting instrument can be the razor, a table knife, etc., however it is necessary to remember, that cutting action can render any other object with sharp edge (a cover of a can, a splinter of glass).

Shape is spindle-like.

Edges equal smooth, sharp ends.

Length of wound, prevail over own depth. Edges of cut wounds are opened which is connected with crossing of elastic fibres of a skin and a wound strongly bleed. Happens, that the cutting object damages also muscles, and sometimes reaches a bone; more often it occurs on those sites bodies where there is an insignificant layer of soft tissue (for example, on a forearm and a shin).

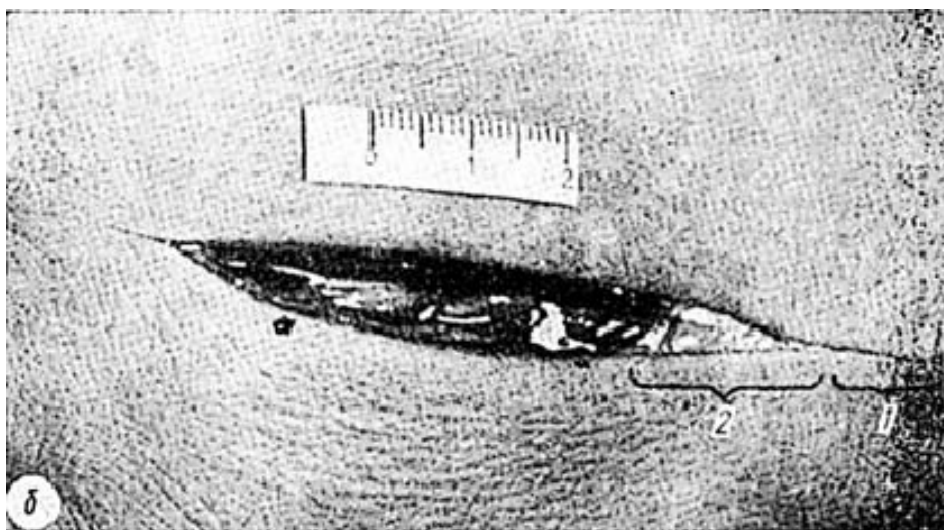


Fig. 4-33. Typical spindle-shape wound on the back surface of the brush with the notch (1) and superficial incise (2).
Caused by a cutting instrument (K.Tamilmani, 2021)⁴

Medico-Legal Importance of an Incised Wound

- 1) It indicates the nature of weapon (sharp-edged).
- 2) It gives an idea about the site of impact and direction of the force.
- 3) The age of the injury can be determined.
- 4) Position and character of wounds may indicate mode of infliction, i.e., suicidal, accidental, or homicidal.

Circumstances of Injuries

The important features of self-inflicted wounds are as follows:

- They are multiple and parallel or nearly so, in any one area.
- They are uniform in depth and direction.
- They are relatively trivial.
- Fatal wounds are present on several limited, easily reachable areas of the body, such as the front of the neck, wrists, groin, and occasionally on the back of legs or on the chest.
- Hesitation marks or tentative cuts or trial wounds: they are cuts which are multiple, small and superficial, often involving only the skin and seen at the beginning of the incised wound.

Stab-incised wounds

Stab-incised wounds are formed by the stabbing-cutting instruments (often knives). These instruments, damaging a skin render simultaneously the spike pricking, and an edge - cutting action. Stabbing-cutting the instrument of type of a knife consists of the handle and blade. Blades of knives can be two types: one-edged and double-edged (daggers).

Shape of stab-incised wounds: fissural, spindle-shape, oval-extended or oval.

Edges of stab-incised wounds are equal and smooth.

End of a wound where the knife blade operated - the sharp, opposite end can be rounded off, rectangular, M-shaped depending on a structure of a butt (not grinded part opposite to an edge of blade).

In the region of the sharp end the additional cuts arising from action of an edge of blade at it are often observed extraction with turn; such damages, as a rule deviate a direction of the length the basic damage, and can sometimes depart from it under a right angle and even to exceed the sizes of the basic damage (so named fish-tail). The ends of such cuts are sharp with passing in a superficial cut.

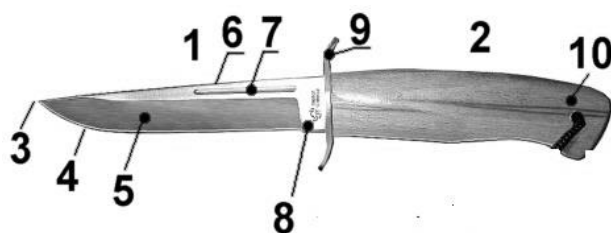


Fig. 4-34. Description of parts of the knife

1. blade; 2. Handle; 3. the point – the end of the knife used for piercing; 4. the edge – the cutting surface of the knife extending from the point to the heel; 5. the grind – the cross section shape of the blade; 6. the spine – the thickest section of the blade; 7. the fuller – the groove added to lighten the blade; 8. the ricasso – the flat section of the blade located at the junction of the blade and the knife's bolster or guard; 9. the guard – the barrier between the blade and the handle which prevents the hand from slipping forward onto the blade and protects the hand from the external forces that are usually applied to the blade during use; 10. the hilt or butt – the end of the handle utilized for blunt force.

Depth of the stab-incised wounds always prevails over own length. Depth of the channel of the specifies length of the plunged part of the blade. However it is necessary to remember, that at stab-incised wounds of a belly cavity it is necessary to consider a pliability of an anterior abdominal wall.

Length of stab-incised wound on a skin (without taking into account length of additional cuts) can specify wounds width of the used blade.



Fig. 4-35. The main part of the stab wounds (A. Aggrawal, 2021)⁸:
a cut-formed bevel blade, *b*-cut, bevel butt formed by immersing the blade,
c- butt ends, *d* - additional cut that occurs when you remove the blad,
 (*a* + *b* + *c*) - the length of the wound, the width of the corresponding blade

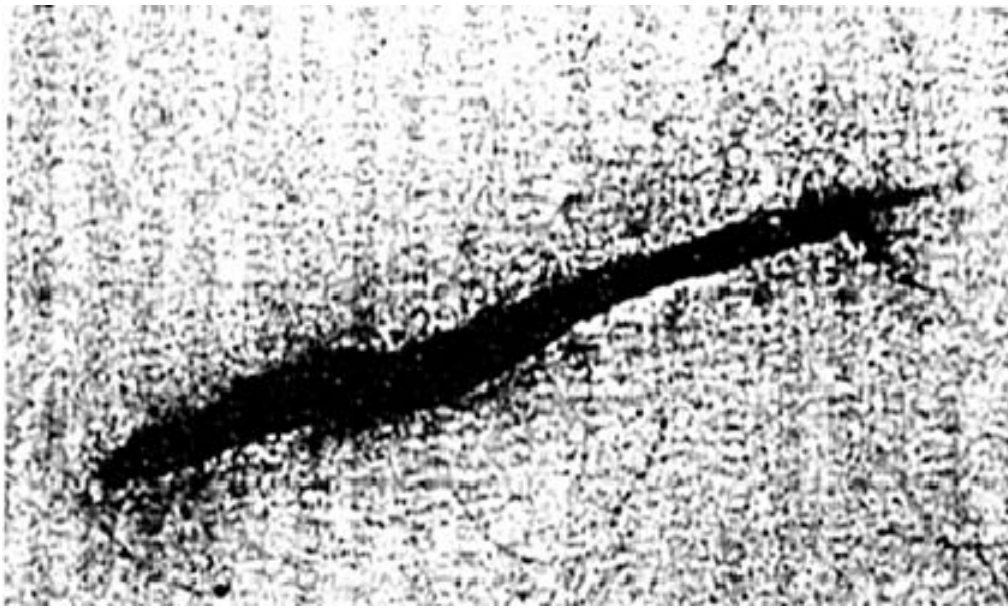


Fig. 4-36. *Stab wound shape of "fish-tail" (N.N. Tagaev, 2003) ³*

At action of the blade under an angle to a surface of a skin (with an inclination aside an edge or a butt) the length of a wound always is more than width of a blade. At inclinations of the blade in aside its lateral surfaces (cheeks) of a wound have the arcuate form. At damage double-edged structure or one-sided sharp weapon with a thin butt (less than 0,2 cm) of blade both of the end damages are represented sharp; at extraction such instruments with rotation, can give additional cuts to a wound the X-shaped form.

Chopped wounds

Chopped wounds are formed by the chopping instrument, which operating by the sharp edge-blade. As chopping weapon axes often are used. It is possible to name such heavy instruments: machete, shovel; chopping action can possess as well even the big knife or a dagger. Chopping instruments (weapon) cause deep linear character of a wound which settle down on a head mainly.

Edges of Chopped wounds, as a rule, not smooth, but regular with small superficial abrasion in the form of narrow strips, hair on edges of such injuries are divided on an identical level, and bruise of edges is expressed much less, than at injuries from action of blunt instruments. Tissues fibres are isolated and, as a rule, they are located down at the ends of such wounds.

Ends of wounds may be sharp, and in cases of the expressed action a forward or back part of an edge of an axe, one of the ends of a wound can be sharp, and opposite can have the rectangular form. If chopping the instrument operates under the angle to a surface of a skin, edge of a wound from a main direction remains an abrasion. On flat bones, in case of perpendicular action of

an edge of the chopping instrument, as result are fractures with attributes of the local and remote influence. Attributes of local influence are expressed in the form of linear character of fracture with equal margins on which surface can stay the smallest parts of the bone. As a result of wedge-shaped actions of the instrument are formed the remote damages of a bone in the form of the cracks departing from the ends of linear fracture.

At immersing a heel or toe of the wedge of an axe the shape of fracture reminds the long triangle, one end of fracture gets rectangular form, and opposite one remains sharp, passing smoothly and "trace-impression". If impact by an edge of the chopping instrument is put under a little angle, the part of a bone from the opposite side to impact breaks off, forming defect of the round or oval form and on a surface of edge of cut it is possible to observe the traces reflecting roughnesses of an chopping edge, in the form of parallel lines (platens and grooves) which direction specifies a direction of movement of an sharp edge.

On width and interposition of these lines probably carrying out of identification of the instrument, i.e. an establishment of the real chopping instrument to which damage has been caused. On tubular bones minced injuries often find out in cases of examination of the dismembered corpse. Traces of influence of the chopping instrument on such bones can be in the form of parallel superficial damages with equal edges and the sharp ends (owing to numerous action of an edge of the chopping instrument). Fracture on a tubular bone in the beginning arises on a scene of action of an edge and a plane cut is equal, on it lines can be formed, and due to wedge-shaped actions rough destruction of compact substance is formed.

Sawn wound

Wounds from action of sawing instruments on appearance remind bruise-lacerated wounds. The form of such wounds often zigzag with the length, focused cross-section of the length to any part of a body. The ends of a wound are rounded. The basic difference from laceration is the smaller quantity of fibres and less expressed abrasions of the edges. Edges consist of the fine triangular rags formed from collected bits of the saw of folds of a skin.

There are plural wounds of a skin from influence of bits of saws, owing to impact by its sawblade in perpendicular direction to a skin. Such wounds remind plural stab-wounds of rhomboid shape. Distance between them and their interposition specify features of a sawblade of the sawing instrument and allow to establish exact copy of the instrument. Saw cut of tubular bones differ from cut of the axe by the presence of precisely expressed defect of a tissue which can be revealed by comparison of the saw cut fragments. The width of this

defect depends on width of the sawblade of the sawing instrument. Such damages possible to meet often at examination of dismembered corpse and less often - at case of an industrial trauma.

FORENSIC-MEDICAL EXAMINATION OF FIREARM INJURIES

Gunshot wounds occur relatively seldom in the practice of forensic expert. Nevertheless, their research is obviously important, as at this research the expert can resolve many questions having sometimes extreme value for the inspector. For a correct estimation of features of fire arm injuries it is necessary to know about a firearms, the mechanism of formation of damages.

Mechanism of formation of firearms damages

It is necessary to know, that the firearms are subdivided on artillery and shooting; the last: in group (machine guns) and manual. The manual weapon can be military (rifles, automatic devices, pistols), hunting, sports, special (alarm), self-made and defective (spoilt) - when its own ballistic data changed. Distinguish smooth-bore and rifled fire-arms.

Classification of Firearms

1. The firearms are sectioned on piece of ordnances (artillery), and shooting.
2. Shooting may be: **group** (machine guns, mortars), and individual (handshot).
3. The **individual shooting** firearms are sectioned into following groups:
 - 1) **According to purpose:**
 - Battle (automatic devices, carbines, pistols, rifles);
 - Hunting (1-, 2-, 3-, 4-barrelled guns);
 - Sports (rifles, pistols, revolvers);
 - Special (alarm, construction pistols).
 - Atypical: self-made and defect.
 - 2) **According to length of a barrel:**
 - Long-barrelled;
 - Short-barrelled (automatic pistols, revolvers).
 - 3) **According to property of a barrel:**
 - Rifled (rifles, automatic pistols, revolvers);
 - Smooth-bored weapons (shotgun);
 - Combined (hunting rifles, sports guns).

- 4) **According to calibre (diameter):**
 - Small-calibre (4-6 mm);
 - Medium-calibre (7-9 mm);
 - Large-calibre (more than 9 mm).
- 5) **According to the mechanism of a shot:**
 - Automatic (machine guns);
 - Semi-automatic (pistols, carbines);
 - Non-automatic (hunting rifles).

The principal types of firearms are:

- 1) *smooth bored firearms;*
- 2) *rifled firearms.*

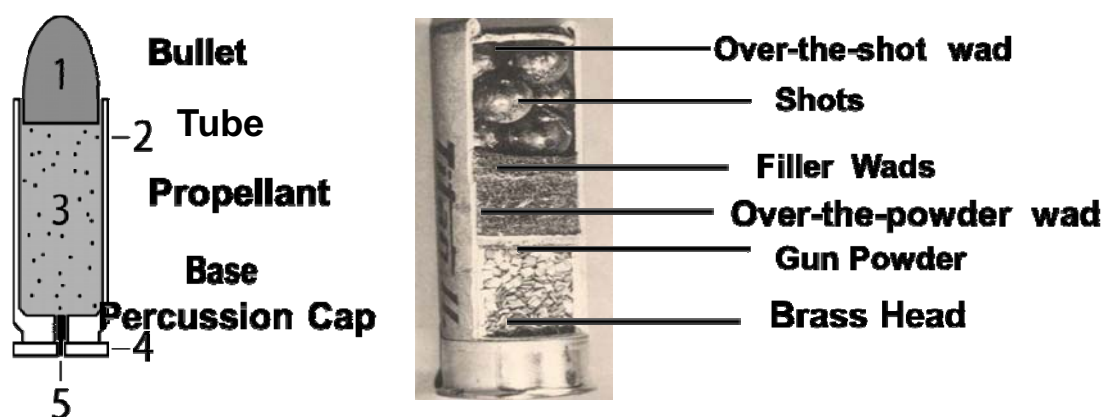


Fig. 4-37. *Parts of rifled weapon cartridge (1); Shotgun cartridge (2)*
(A. A. Babanin, 2007)⁵

A shell in rifled firearms is the bullet. It is necessary to distinguish 4 kinds of action of a bullet, namely:

1) penetrative - when the bullet possesses significant kinetic with energy also operates as a punch, beating out a slice of a tissue (more often in total this action is observed in the field of an entrance aperture);

2) wedge-shaped (shown in the field of an exhaust outlet) - when kinetic energy of a bullet is considerably lowered, and it only moves apart tissues, as a wedge;

3) contusion or bruised - when the bullet, having insignificant kinetic energy (for example, spent, at passage through a barrier before hit in a body), operates, as a blunt firm object, causing grazes, abrasions without formation of a wound);

4) explosive (it can be observed in two cases) - when the bullet has a special explosive or, possessing the big kinetic energy, it gets in hollow body filled by a liquid where makes so-called hydrodynamical influence.

It is necessary to remember, that the various mechanism of action of a bullet in the field of entrance and target apertures causes occurrence of the characteristic attributes, allowing to spend their differential diagnostics.

Features entrance and exit gunshot wound

The entrance aperture on a body refers to as an entrance bullet wound. The form of a bullet wound usually round or oval. Thus the aperture has a number of the characteristic attributes caused by penetrative action of a bullet. Among these attributes it is necessary to pay attention to the following:

1. **Defect of a tissue** (minus a tissue) is a place of the skin which have been beaten out by a bullet. To define it follows by comparison of edges of a wound. If they do not approach or approach with formation of folds of a skin, it testifies to presence of defect of a tissue.

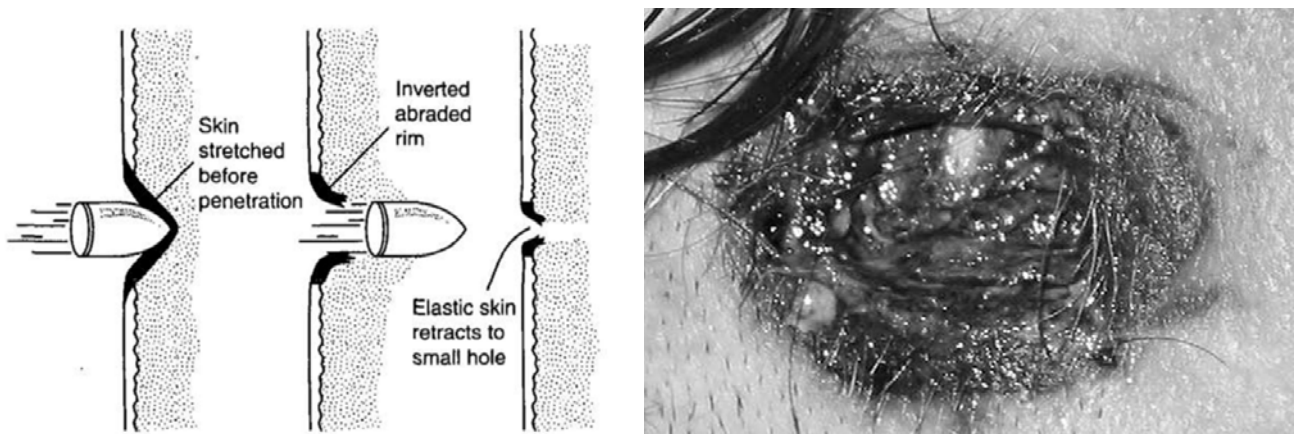


Fig. 4-38. Entrance wound formation (A.A. Babanin, 2007)⁵

2. **Abrasion collar**- a ring of pink-red color formed because a bullet, entering into a body, involves a skin and a lateral surface tears off epidermis on edge of an aperture for the width 0,1-0,3 cm. Depending on a corner under which the bullet has entered into a body, a waist of the abrasion can be ring-shaped or arched. It is necessary to remember, that on a corpse a collar has dark brown color as a result of drying of skin.

3. **Dirt collar** — a ring of grey or black color in width 0,1-0,3 cm. It's formed because the bullet carries on itself various parts (a soot, a powder deposit, traces of greasing, a rust) and, entering into a body, leaves (wipes off) these parts around of an entrance wound. Dirt collar can partially or completely be imposed on waist of the abrasion.

4. **Metallic collar** is formed as a result of adjournment erased scales of metal of an internal surface of the trunk, the bullet, and also an explosive mix of capsule and can be revealed radiographic, chemical, electrographic or spectrographic by methods of research.

Except for described above it is necessary to consider, that edges of an entrance aperture mostly equal or small-notched (at viewing by means of a magnifier), sometimes as though screwed inside, and its size of often less diameter of a bullet.

The exit wound is formed as a result of wedge-shaped actions of a bullet in this connection it has fissure or star-shaped form. At its research it is necessary to pay attention to absence of defect of a tissue, collar of the abrasion, dirt collar and metallization. It is necessary to mean, that edges of a wound in these cases are rough, big-notched (character of edges of a laceration), are turned outside. It is necessary to remember also, that on occasion in the field of an exhaust outlet defects of a tissue can be observed (if the channel of the wound is short and the bullet has not lost penetrative ability) and so-called false collar of the abrasion, formed when during the moment of an output of a bullet the skin has been pressed to something dense. Unlike true false collar of the abrasion has non-uniform width.

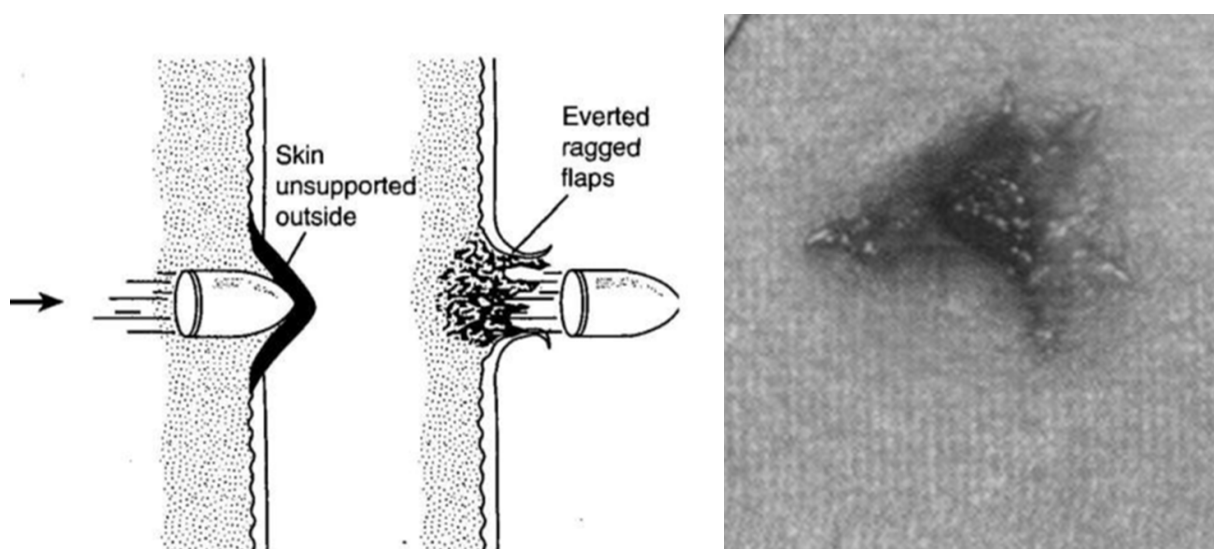


Fig. 4-39. Exit wound formation (A.A. Babanin, 2007)⁵

Definition of a distance of a shot and accompanying components

Distance of a shot is a distance from muzzle cut of fire-arms up to amazed object. Correct definition of a distance of a shot has the big practical value. It is necessary to know, that in forensic medicine distinguish three distances of a shot: contact shot, close shot and distant shot. Formation of an entrance bullet wound at various distances is influenced with accompanying components of a shot.

Accompanying components of a shot are all that take off from the channel trunk of fire-arms during the moment of a shot, except for a shell (bullets, fractions). It is necessary to carry a prebullet column of compressed air, a flame, powder gases, a soot, not burned down grains of gunpowder, a particles of metal, gun greasing.

It is necessary to consider, that on close distance (up to 3-5 cm) air of prebullet space, possessing kinetic energy, can cause damages in the form of a bruise or areas of air abrasion and even to form break of a skin.

A fire of the shot is a volume of gas in which there is a burning. At shots by modern smokeless gunpowder the action of a flame is less expressed by gunpowder and extends on 20-30 cm from muzzle cut whereas at a shot smoky gunpowder the flame can extend up to 100 cm.

Powder gases - a product of combustion of gunpowder at a shot. It is necessary to consider, that powder gases possess mechanical, chemical and thermal action. At a shot or from very close distance they get into an emphasis under the skin and can cause its breaks, exfoliations, breaks of internal organs. Powder gases on a close distance possess contusion action. Thus the skin abrasion, is condensed and, drying up, forms a spot which represents a yellow-brown site of parchment density.

Chemical action of gases consists that at combustion of gunpowder the significant amount of oxide carbon which enters connection with hemoglobin of blood is formed and forms carboxihemoglobin. Blood thus gets bright red color and can serve one of differential attributes entrance and an exhaust outlet. Thermal action of gases is insignificant more often. Thus it is expressed more strongly at black smoky gunpowder, than smokeless one.

Soot of a shot are fine particles of various structure which are born from the channel of a trunk by powder gases. It is necessary to know, that the soot of smoky gunpowder consists basically of carbon and its salts. The soot of without smoke gunpowders is formed owing to decomposition of products of capsule structure, instead of gunpowders and consists of metals (lead, copper, antimony, etc.). It is necessary to consider, that intensity of adjournment of a soot, the form of its adjournment, the area depend on concrete distance of a shot and positions of the weapon in relation to amazed object. At a shot under a right angle the soot is postponed in the form of a circle. More close to a wound its color is more sated, than to periphery. At a shot under a corner the form of adjournment of a soot gets a figure of an ellipse. The wound thus settles down more close to the party of an ellipse, the shot whence has been made. The soot flies on distance till 30-50 cm.

Grains of gunpowder – it's half-burned or not burned down particles, taking off from the channel of a trunk. It is necessary to mean, that they, possessing the certain weight, can abrasion an epidermis, take root into a skin and in wound channel. The special research of grains of gunpowder can establish its kind.

Contact shot is a shot during which muzzle of the gun joins to a surface of a body. It is necessary to distinguish three kinds of an contact shot:

1. Full contact– muzzle of the gun is hermetically put to a body. In these conditions prebullet air causes damage earlier, than a bullet which passes through the formed wound. At this kind of an emphasis around of a wound the print of muzzle of – special print (stamp-print) can be formed. The stamp-print can look like a graze, abrasion, a parchment spot. It is formed mainly because of action of gases which extending under a skin, press down it to muzzle of the gun. Thus protruding skin under action of gases can be such, that grasps the details of a trunk located on significant enough distance from muzzle of the gun, for example, a front sight, its rack, post.

2. Loose contact shot - nonhermetic, at which a muzzle of the gun only puts to a body. It is necessary to know, what exactly at this kind of an emphasis forms extensive breaks and tearing of a skin and around of a wound it is possible to observe small adjournment of a soot, without stamp-print of the muzzle.

3. Partial or lateral - a shot from the weapon under a corner, when muzzle of the gun joins to a body only by one part. Thus can observe attributes of a shot in an emphasis and from close distance - a print of a part of muzzle of gun and adjournment of a soot (from a blunt corner).

From close distance it is necessary to understand as a shot such distance when besides a shell on a leather additional factors of a shot operate. And depending on distance on which these factors extend, around of a wound action all of them (can be revealed at very close distance) or only one of them (for example, grains of gunpowder). To define precisely in centimeters a distance of a shot under additional factors in essence it is impossible. For the decision of this question in practice it is necessary to resort to experimental shooting from the same weapon and an ammunition passing on case, observing thus a number of special conditions. It is necessary to remember, that display of action of additional factors of a shot in itself specifies that wound - fire, that an aperture - entrance, that the shot is made from the close distance, the certain direction, and also in the dressed or naked body.

The distant from shot distance is characterized by that on a body one shell (a bullet, fraction) operates only. Under these conditions the wound, describing is formed by attributes which are described above.

Gunshot wound (bullet) channel

Gunshot wound the channel - a way laid by a shell in a body, is continuation of a bullet wound. It is necessary to distinguish 7 kinds bullet channels:

1. A straight line - passes through all tissues and organs on one line.
2. Broken - arises when after passage of a bullet there is a displacement of internal organs (for example, displacement of loops of intestines, compression of a lung in connection with hemopneumothorax, etc.). It is necessary to know, that at two bullet channels if one of them broken, and other straight line, it is possible to establish sequence of causing of wound - a straight line can be only after broken.
3. Rejected - it is formed when in a body occurs ricochet (rebound) of bullets. By practice and experimental researches it is established, that if the bullet meets a barrier (not necessarily firm) under a corner up to 15°, approximately in 25% cases occurs it ricochet.
4. Tangential - it is possible to observe, when the bullet operates on a tangent on round parts of a body (a head, a shoulder). It is necessary to distinguish two their subspecies - closed when there is entrance and target apertures and between them a short bullet channel, and opened when the wound having the form of a trench is formed.
5. Surrounding - it can be formed when a bullet, possessing small kinetic energy, having punched a leather and having met a bone (for example the skull, a rib), as though slides after it continuing the way on hypodermic subcutaneous fat, and leaves in the opposite side.
6. Interrupted - arises when the bullet passes through some parts of a body (for example through a forearm and a thorax).
7. Plural - it is possible to observe when bullet before hit in a body or in a body for whatever reasons makes fragments, forming a little bit blind or through wound channels.

Firearm injuries of bones

At research of firearm injuries it is necessary to consider, that in bones the bullet channel has the original form. In particular, in flat bones (a skull, a scapula, a coxae, etc.) it has the form of the truncated cone extending aside of flight of a bullet. If the bullet has entered into a bone under a right angle on an external plate the aperture has the round form, its diameter is equal or hardly less calibre of a bullet. If the bullet has entered in a bone under a corner on an external plate the aperture has the oval form, and from a blunt corner is available scratch of the external bone plate.

In long tubular bones at gunshot wounds splintered or holed-splintered fractures more often are formed. Having compared parts of the bones, in the field of an input of a bullet it is possible to find out an aperture of round forms from which mainly radial cracks forming scratches triangular or trapezoid shapes are formed. In the field of an output of a bullet of a crack mainly longitudinal, incorporating among themselves cross-section.

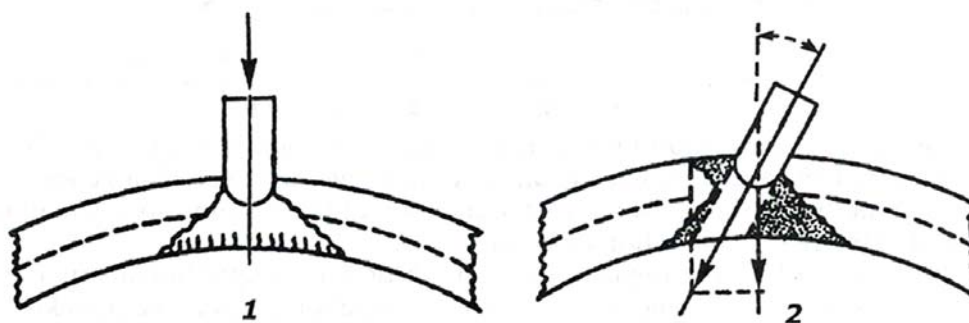


Fig. 4-40. Damage of flat bones by a bullet:

1 – action a bullet perpendicular to a surface of the bones;

2 – under an acute angle (A. A. Babanin, 2007)⁵

It is necessary to remember, that at research of fire damages on the bones, sometimes later many years, and sometimes and decades, the establishment not only entrance or an exhaust outlet, a direction of a shot and calibre of a bullet, but also the decision of other questions - about system of fire-arms, a chemical compound of an environment of a bullet, distance of a shot and sequence of causing of damages is possible at plural wounds.

Chapter 5

FORENSIC-MEDICAL EXAMINATION OF MECHANICAL ASPHYXIA

Forensic-medical examination of mechanical asphyxia is an important section of forensic medicine. Asphyxia (Greek meaning pulselessness) is a condition caused by interference with respiration or due to lack of oxygen in respired air (anoxia, hypoxia), due to which the organs and tissues are deprived of oxygen (together with failure to eliminate CO₂), which may cause unconsciousness and death.

In mechanical asphyxia, the air-passages are blocked mechanically.

Classification of Mechanical Asphyxia

I. Asphyxia by compression:

a) Strangulative asphyxia:

- Hanging;
- Ligature Strangulation;
- Strangulation by hands (extremities).

b) Compressive Asphyxia

- External compression of the chest and abdomen interfering with respiratory movements.
- External compression of the chest
- External compression of the abdomen

II. Asphyxia by closure:

a) Obstructive asphyxia:

- Closure of the external respiratory orifices, as in Smothering.
- Closure of the airways by the impaction of foreign bodies in the larynx or pharynx, as in Choking.

b) Aspirative asphyxia:

- By loose substances, by fluid, by blood, by vomitive masses, etc.
- Drowning

III. Insufficiency of oxygen in the inspired air (in enclosed places, trapping in a disused refrigerator or trunk. It can happen at a placement of child or only his head in a plastic bag.

Common (general) asphyxial Signs

External:

- 1) Livores mortis is well developed.
- 2) The face is often cyanosed and purple, and sometimes swollen and oedematous.
- 3) The eyes are prominent, the conjunctivae are congested and the pupils are dilated.
- 4) Petechial haemorrhages in the conjunctivae.
- 5) Involuntary defecation, urination, discharge of seminal fluid, pushing mucus plug from the cervix — valuable but non-permanent signs.

Internal:

- 1) Dark liquid blood in the heart and large venous vessels.
- 2) Venous congestion of inner organs. The large veins are full of blood.
- 3) Spleen anaemia.
- 4) Overflow by blood of the right part of the heart and at the system of superior vena cava.
- 5) Petechial subepycardial and subpleural haemorrhages.
- 6) Acute alveolar emphysema

SEPARATE KINDS OF A MECHANICAL ASPHYXIA

Hanging

Hanging is the form of asphyxia which is caused by suspension of the body by a ligature, which encircles the neck, the constricting force being the weight of the body.

The position of a Ligature on the neck can be typical, when the knot is located from behind and atypical - at location of knot in front, or on the right or left side of the neck.

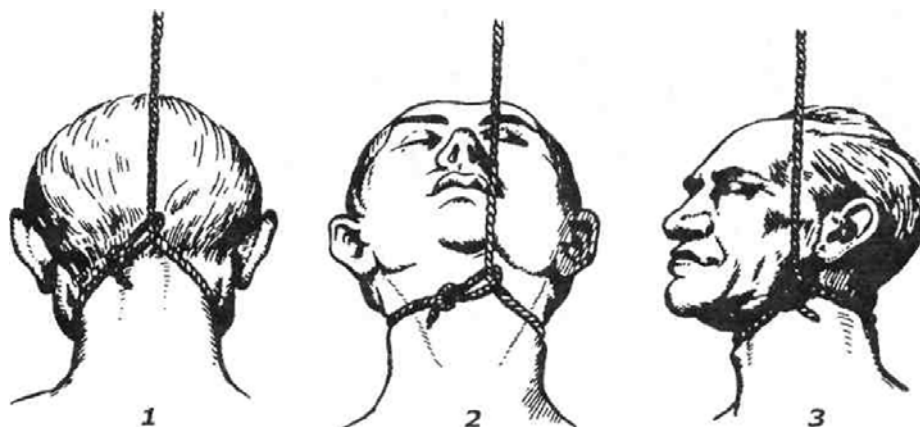


Fig. 5-1. Positions of the ligature:

1 – typical, 2, 3 – atypical (A. A. Babanin, 2007)⁵

Hanging can be full and partial. In "partial hanging" the bodies are partially suspended or are in a sitting, kneeling, lying down, prone or any other posture. The weight of the head acts as the constricting force. Partial hanging may occur simply by leaning against the noose secured to a chair or doorknob, the leg of a table, at bedpost or rail, or the handrail of a stair case, which is slightly higher than the position of the head, the deceased being in a kneeling position, or slumped back or forward and lies prone with only the face and chest off the ground. In these cases, the constricting force is less and congestive changes are more marked.

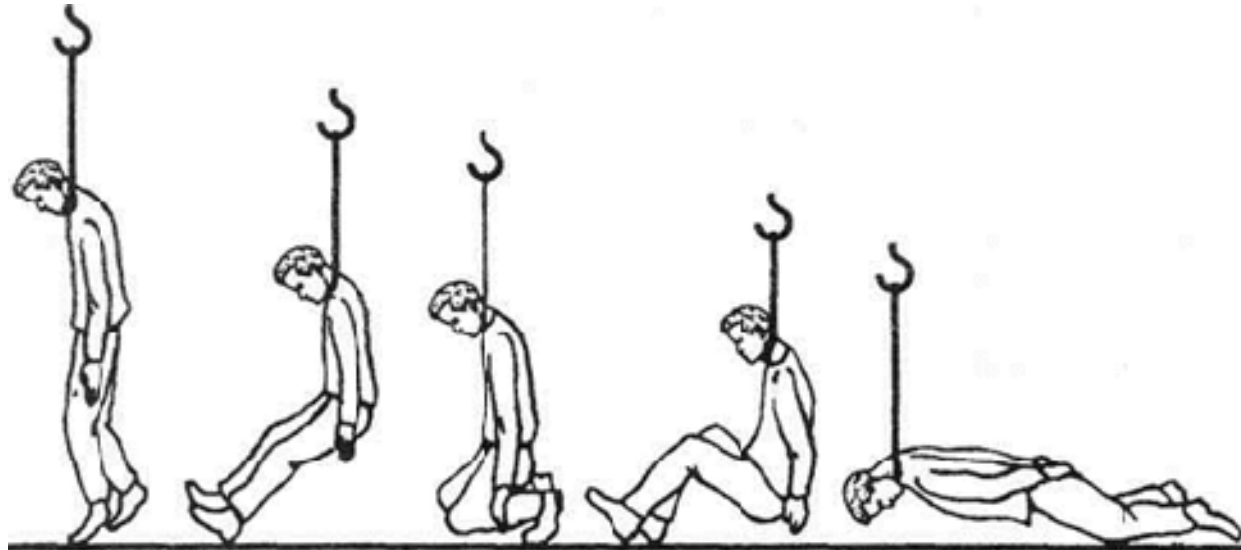


Fig. 5-2. Postures at Hanging A.A. (Babanin, 2007)⁵

Post-mortem signs

The General asphyxial signs will be present. The most important and specific sign of death from hanging is the Ligature Mark in the neck. It is imprint of a loop on the skin of the neck. The ligature produces a groove in the tissues, which is pale in colour, but it later becomes yellowish or yellow-brown, hard and parchment-like due to the drying of the slightly abraded skin. It is oblique, does not completely encircle the neck; usually seen at high up of the neck between the chin and larynx.

In the typical case of a fixed loop, the mark is seen on both sides of the neck, and is directed obliquely upwards towards the position of the knot over the back of the neck. In partial hanging when the body leans forward, a horizontal ligature mark may be seen.

The ligature mark usually encircles the entire neck, except for the place where the knot was located. The mark is situated above the level of thyroid cartilage. The width of the groove is about, or slightly less than width of the ligature.

Ligature Strangulation

Ligature Strangulation is that form of mechanical asphyxia, which is caused from constriction of the neck by a ligature or a part of other flexible object by their tension, a force of extraneous or own human arms or any mechanisms.

At ligature strangulation on a corps we found the general (common) asphyxial signs and ligature mark. The ligature mark is situated at the level of thyroid cartilage or below, is almost horizontal, and encircles the neck completely. The mark may be absent on the any area due to the presence of clothing or long hair between the ligature and the skin.

The character of the mark depends upon the nature of ligature but is also affected by the number of turns round the neck and length of time it remains applied. The pattern of the ligature may be imprinted on neck as a pressure abrasion (mirror image phenomenon) or bruise. If the ligature has gone round the skin more than once, corresponding number of marks, one above the other and close to each other are seen. In such cases, there may be evidence of skin bruising if it is caught between the rounds of ligature. There is always some damage to skin underneath the ligature. A careful search of the neck may reveal minute fibres or any other material from the ligature. The ligature should be examined for presence of blood, hair, or suspicious substances.

Strangulation by Hand (Hands, Extremities)

Asphyxia produced by compression of the neck by human hands is called Strangulation by hands, or extremities (syn.: Throttling, Manual Strangulation).

External signs

The bruises are produced by the tips or the pads of the fingers. Their shape may be oval or round and of the size of the digits, but continued bleeding into the contused area usually increases the size.

A grip from right hand from the front produces a thumb impression on the right side of the victim's neck, which is usually under the lower jaw over the cornu of thyroid. Several finger-marks are seen on the left side of the neck obliquely downwards and outwards, and one below the other, but sometimes are grouped together and cannot be distinguished separately. In a grip from behind the victim, the pressure is applied all round the neck, but some areas of bruising are more prominent due to the pressure of the fingertips.

When both hands are used to compress the throat, the thumb-mark of one hand and the finger-marks of other hand are usually found on either side of the throat. Sometimes, both thumb-marks are found on one side and several finger-

marks on the opposite side. A grip from both hands, one being applied to the front and the other to the back, produces bruises on the front and back of the neck. Due to the shifting of the grip, and sometimes the frank struggle of victim, bruises may be seen in a completely haphazard manner. If the fingertips are pressed deeply, the pressure of the nails produce crescentic marks on the skin. If a soft material is kept between the hand and throat, bruising may not be seen. Marks of struggle are similar to those found in strangulation.

Internal signs

The larynx is usually squeezed, and fractures are common especially in old persons with calcified cartilages. Fracture of the superior cornu of the thyroid at its base is common due to the local pressure, but the extent of damage varies. Often, only the right horn may be broken to which the thumb was applied. Fractures of the body of the thyroid cartilage are rare.

External Compression of the Chest and/or Abdominal Walls

External compression of the chest and/or abdominal walls (Compressive Asphyxia) is a form of asphyxia resulting from external pressure on the chest, abdomen, or back, which prevents normal respiratory movements.

Post-mortem signs

In addition to signs of asphyxia, and mud or other foreign material on clothing as the case may be, there are three characteristic features: "ecchymosed mask", pulmonary carmine-red oedema, and line of demarcation.

The mechanism of Compressive Asphyxia is as follows: The face and neck of the victim are deeply cyanosed-almost black, the eyes blood-shot, and numerous petechiae are found over scalp, face, neck, and shoulders ("ecchymosed mask") because compression of the chest displaces blood from the superior vena cava and subclavian veins into the veins and capillaries of the head and neck. No valves are present in superior vena cava because backpressure is normally not present in the venous system above the level of heart. Valves in subclavian veins prevent spread of the hydrostatic force set up in the blood column to the veins of upper limbs. The valveless veins and capillaries of the head and neck are therefore considerably engorged and the hydrostatic pressure in them rises so rapidly as to burst their walls.

The level of compression is indicated by a well-defined line of demarcation between the discoloured upper portion of body and the lower normally coloured part.

The tissue of the lungs on section is oedematous, shining, of carmine-red colour.

Obstruction of the Airways

Smothering

Smothering is a form of asphyxia which is caused by closing the external respiratory orifices either by the hand or by other means, or by blocking up the cavities of the nose and mouth by the introduction of a foreign substance, such as mud, paper, cloth, etc.

Post-mortem signs

In Smothering, abrasions and bruises are generally found in the region of nose and mouth. However, these may be absent if the face has been pressed against soft material, such as a pillow or bed clothes. In such cases, particular attention should be paid to the sides of head and neck for any possible signs of violence. Injuries on the inside of lips from pressure against the teeth, bruising of gums, or sometimes superficial splits in delicate tissues, such as fraenum of the lip or tongue may be found. They may be missed at autopsy unless specially looked for. These injuries are usually produced as a result of struggling and may therefore be absent in infants, young children, the aged, intoxicated, and debilitated persons.

On microscopy, the findings are usually entirely non-specific but mild acute emphysema, oedema of the lungs, scattered areas of petechiae and congestion may be found. The air passages often contain eosinophilic fluid with red blood cells and varying amounts of desquamated respiratory epithelium.

Choking

Choking is a form of asphyxia caused by an obstruction within the air-passages by a foreign object.

Choking commonly occurs during a meal when food is accidentally inhaled, especially when the victim is laughing or crying. Infants usually regurgitate clotted milk after a meal, and this may fall into the larynx. Impaction of solid bodies, such as a large bolus of food, seeds, piece of meat, live fish, mud, leaves, or a set of false teeth may cause asphyxia, and etc. Gauze packs inserted during an operation can be inhaled and cause death. Children often place objects like marbles, coins, rubber balloons and etc. in their mouths, which may pass into larynx or trachea during a sudden deep inspiration. Choking due to regurgitation of food may occur in alcoholic intoxication (usually during a sleep).

Post-mortem signs

The foreign body, which caused the occlusion of air-passages, will be found in the mouth, throat, larynx or trachea. When loose substances, food or vomited matter has been inhaled, particles of this material may be observed

embedded in thick mucus in the trachea and bronchi, and particles may be drawn into the bronchioles which distinguishes the condition from those cases in which food is forced up the esophagus and falls into the larynx after death. Other signs of asphyxia will be seen.

Drowning

Drowning is a form of asphyxial death in which access of air to the lungs is prevented by submersion of the body in fluid medium (typically the entire body). The liquid is most commonly water but drowning can occur in any liquid, e.g., beer, wine, gasoline, bitumen, dye, paint or some other chemical solution. It is necessary to distinguish 4 main types of drowning in water: *aspirate, spastic (asphyxial), reflex (syncopal), mixed*.

Diagnostic signs of Aspirate type

Foam in the airways: Externally a fine white froth or foam is seen exuding from the mouth and nostrils (*Krushevsky's sign*).

The froth is sometimes tinged with blood producing a pinkish colour. If the foam is wiped away then pressure on the chest wall will cause more to exude from the nostrils and mouth. It is persistent and resists submersion for several days (up to a week in winter). The foam is also found in the trachea and main bronchi.

The foam is a mixture of water, air, mucus and surfactant whipped up by respiratory efforts. Thus it is a vital phenomenon and indicates that the victim was alive at the time of submersion. Similar foam is found with severe pulmonary oedema from any cause such as drug overdose, congestive cardiac failure and head injuries.

Emphysema aquosum ("emphysema hydroaerique"): The lungs in fresh water drowning are voluminous, bulky, ballooned, may completely cover the heart, and bulge out of the chest when the sternum is removed. They retain their shape and often show impressions of ribs upon them. Their surface is pale and they pit on pressure. On sectioning there is a flow of watery material. The appearances reflect active inspiration of air and water and cannot be reproduced by the passive flooding of the lungs with water. However the appearances are not generally distinguishable from pulmonary oedema.

Larger ecchymoses are sometimes seen in the interlobar surfaces of the lower lobes (*Rasskazov-Lucomsky-Paultauf's haemorrhages*). Haemorrhages are the result of tears in the alveolar walls and this is the explanation for the occasional blood tinging of foam in the airways. Subpleural bullae, which may be haemorrhagic, are occasionally found.

Water in stomach and intestine: The stomach often contains water that has been swallowed during the struggle for life. This may be salty or fresh,

clean or dirty, and may even contain algae, weeds, mud or sand, varying according to the medium in which drowning has taken place.

Other signs: Oedema of the gallbladder's bed, of the brain, increased transudation of liquid in serous cavities is marked. In the bladder the large volume of urine is marked.

The microscopic appearance varies from being suggestive of drowning to entirely normal. Aspiration of large quantities of water results in over distension of the pulmonary alveoli (emphysema aquosum) the alveolar septae are thinned and stretched with narrowing and compression of the capillaries. The appearances resemble pulmonary emphysema.

Diagnostic signs of asphyxial type

The spastic (asphyxial) type of drowning is connected to occurrence of stable laryngospasm as response to irritation of the receptor apparatus of the laryngeal mucous membrane by environment water that prevents the spread of water into respiratory ways and lungs. The phenomena of acute lung hyperaeration with damage of pulmonary structural elements are developed.

The spastic type of drowning, having not signs of penetration of the water in lungs and blood circulation due to laryngospasm, can be objectively proved by diagnostic signs: liquid in sphenoid sinus (Sveshnikov's sign); acute pulmonary emphysema; air embolism of the left heart; retrograde regurgitation of erythrocytes in the lumen of the thoracic lymphatic duct; internal organs are sharp plethoric with petechial haemorrhages; water in stomach and intestine.

Diagnostic signs of reflex type

The reflex (syncopal) type of drowning is caused by the synchronous termination of respiratory and cardiac functions at sudden ingress of the person into extreme conditions.

This type of drowning is not characterized by laryngospasm and penetration of the water Environment into the organism, that why any changes in lungs are not arises. Sharp pallor of integuments and skeletal muscles due to angiospasm, acute hyperaemia in system of venae cava inferiores and signs of acute death are marked. Careful histological research is necessary, especially of endocrine system that permit to establish presence of acute functional disorders in the organism. Thus, the reflex type of drowning has not diagnostic signs and can be determined on the basis of a data set of circumstances of incident, the anamnesis and results of autopsy excluding an opportunity of other variants of thanatogenesis.

Laboratorial tests for drowning

1) Chemical analysis: Attempts have been made to use chemical analysis of the blood on the right and left sides of the heart to detect electrolyte changes in both fresh and sea water drowning.

Specific gravity of blood: This test was first proposed in 1902. It is suggested that a lower plasma specific gravity in blood from the left side of the heart when contrasted with blood from the right side of the heart reflects haemodilution produced during the drowning process.

Plasma Chloride: This test was first proposed by Gettler in 1921. The plasma chloride levels in blood from the left and right sides of the heart are compared.

Plasma Magnesium: This test was proposed by Moritz in 1944. A high level of plasma magnesium in left heart blood when contrasted with right heart blood is considered to reflect absorption on that ion from the drowning medium particularly salt water.

2) Histological examination: For detailed histological studies of lungs one central and one peripheral section from each lobe is recommended. The tissue should be cut with a sharp knife avoiding squeezing out of the fluid content. Microscopy as well as chemical analysis of the gastric contents may be useful in this regard.

3) Diatoms: Most natural waters contain diatoms, a class of microscopic, unicellular algae, suspended in water. They have a siliceous cell wall, which resists acid digestion, heat, and putrefaction. Only a live body with a circulation can transport diatoms from the lungs to the brain or bone marrow from where they, may be detected microscopically after suitable treatment.

Since diatoms resist putrefaction, diatom test may have some value in examination of decomposed bodies. The test is negative in dead bodies thrown in water and in dry drowning.

4) Cryoscopic analysis: it is based on definition of a difference of temperature in the right and left heart.

5) Toxicological studies should include estimation of blood alcohol, sedatives, and antiepileptic drugs, etc.

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NOTES

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СУДОВА МЕДИЦИНА

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(Англ. мовою)

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