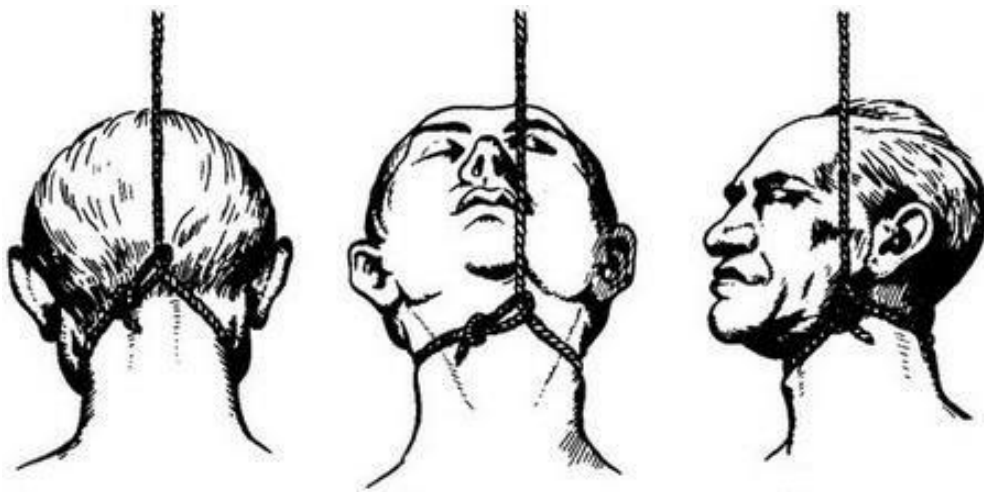


**Module 1. The organization of forensic-medical examination and general problems of forensic medicine. Forensic-medical principles of examination violent and natural death**

**The sub module 4. Forensic-medical examination of damages and death caused by mechanical factors**

## **Theme 12. Forensic-medical examination of mechanical asphyxia**

*Guidelines for students and interns*



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*Методичні вказівки  
для студентів та лікарів інтернів*

**МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ**  
**Харківський національний медичний університет**

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Module 1. The organization of forensic-medical examination and general problems of forensic medicine. Forensic-medical principles of examination violent and natural death. Sub module 4. Forensic-medical examination of damages and death caused by mechanical factors. Theme 12. Forensic-medical examination of mechanical asphyxia: guidelines for students and interns / comp. Vasil Olhovsky, Mykola Gubin, Petr Kaplunovsky, Vjacheslav Sokol. - Kharkiv: KNMU, 2014.

Compilers: Vasil Olkhovsky  
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Vjacheslav Sokol

Модуль 1. Організація судово-медичної експертизи та загальні питання судової медицини. Судово-медичні засади експертизи насильницької та ненасильницької смерті. Змістовний модуль 4. Судово-медична експертиза ушкоджень та смерті від механічних чинників. Тема 12. Судово-медична експертиза механічної асфіксії: методичні вказівки для студентів та лікарів інтернів / упор. В.О. Ольховський, М.В. Губін, П.А. Каплуновський, В.К. Сокол. – Харків: ХНМУ, 2014.

Упорядники: Ольховський В.О.  
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Сокол В.К.

**Substantiation of the Topic.** 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 CO<sub>2</sub>), which may cause unconsciousness and death.

**Duration of practical classes:** 3 academic hours

**Purpose of the Practical Class:** to reveal and describe signs of death in cases of mechanical asphyxia, to diagnose its types and to make medico-legal conclusions.

**Direct purpose of study:**

1. Reveal general asphyxial signs at autopsy;
2. Differentiate various types of mechanical asphyxia;
3. Make expert conclusions according to the tasks on cards in case of death from mechanical asphyxia;
4. Perform forensic autopsy at death from all kinds of mechanical asphyxia.

**Basic level of knowledge and skills (before the practical class):**

1. General information on hypoxia and asphyxia;
2. Stages of asphyxia;
3. Pathological changes in a human body and tissues due to asphyxia.

**Visual Aids and Material Tools**

1. Different natural specimens (human skin with ligature mark, fragments of skeleton and internal parenchymatal organs) and some reports of autopsy;
2. Studying tables, photos, and video.

### **Technological card of carrying out of practical classes**

<b>№</b>	<b>Level</b>	<b>Time (min)</b>	<b>Manuals</b>	<b>Place of carried</b>
1	Control of initial level of knowledge on the topic	15	Oral answering	Class room
2	Analysis the scheme of the description asphyxial signs	15	Tables with scheme	Class room
3	Studying theme of classes, description changes of a skin on natural preparations	35	Natural preparations	Class room
4	Conclusion about character of described damages	35	Natural preparations	Class room
5	The decision of situational tasks	30	Situational tasks	Class room
6	Classes summarising	5	-	Class room

### **BLOCK OF INFORMATION**

In mechanical asphyxia the air-passages are blocked mechanically.

In intravital development of Mechanical Asphyxia there are 2 periods lasting 5-7 minutes and known as preasphixyal period and asphixyal period. The preasphixyal period is a delay of breath. It is not asphyxia. A person without any harm to his/her health can delay breath during 10-15 seconds, but if the obstacle is not removed the

next period develops. The asphyxial period has 5 stages: 1) Stage of inspiratory dyspnea; 2) Stage of expiratory dyspnea; 3) Stage of relative rest (terminal pause); 4. Stage of terminal breath; 5) Terminal Stage. The duration of each stage can be from 1 to 3-5 minutes. In the beginning dyspnea has inspiratory character. In the clinical aspect, it is expressed by enhanced deep inspiration at which the organism tries to compensate lack of oxygen. Thus, the thorax sharply extends, which complicates transition of blood in arteries. Blood overfills the right half of heart and passes in venous system. Then the expiratory dyspnoea develops featured by expiration movements, increase of muscular weakness, cyanosis and swelling of the face; complete loss of consciousness, convulsions, involuntary discharge of faeces, urine and seminal fluid develop.

In Stage III a short respiratory standstill due to depression of functions of the respiratory centre.

Stage IV appears at the 4<sup>th</sup> or 5<sup>th</sup> minute when deep breath and pauses develop. Terminal breath is caused by depression of functions of the respiratory centre and weak stimulation of the spinal cord centres.

Stage V (terminal) is complete respiratory standstill. Heart can function within 5-30 minutes.

### ***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. *They are most marked where for mechanical reasons, capillary congestion is most prominent. Their distribution lies above the level of obstruction. They appear commonly as a rash-like shower in the scalp, eyebrows and face in hanging and strangulation, and in the zone above the level of compression in traumatic asphyxia. They are produced by simple mechanical obstruction to the venous return of blood from the parts, resulting in acute rise in venous pressure and over-distension and rupture of thin-walled peripheral venules and capillaries, especially in lax unsupported tissues, such as the eyelids, forehead, and skin behind the ears, circumoral skin, conjunctivae and sclerae.*
- 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. *The postmortem fluidity of the blood is due to presence of fibrinolysins. Under certain conditions, the fibrinolysin may be so active that fibrin is destroyed as rapidly as it is produced, and post-mortem clots never develop in the vessels. In other cases, thrombi are formed, but they undergo lysis.*
- 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. *These are often referred to as Tardieu spots, after the French Police Surgeon who described them in 1866.*
- 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.

### **Ligature Mark**

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).

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.

### **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. In mild cases of traumatic asphyxia, injury to the lungs may be in the form of traumatic emphysema wherein the air in the lungs is forcibly redistributed producing small bullae along the edges of the lung.

Depending on the mechanism of trauma, other injuries may be found in various other parts of the body (e.g., fracture of the ribs, which are usually bilateral, multiple).



The cause of death is asphyxia, but not injury in this case.

## **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.

### ***Choking***

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

### ***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**

*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.

Contrary to expectations lung weights in fresh water drowning are not statistically different from lung weights in salt water drowning. The average lung weight is approximately 700 g with a standard deviation of approximately 200 g so that in a minority of cases the lungs are "dry".

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.

The lungs in salt water drowning are heavy and more markedly waterlogged. After the body has been in water for a few hours, these changes gradually disappear, and the difference in appearance of the lung in salt water drowning and fresh water drowning becomes far less clear. Tardieu spots are seldom seen.

*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. This is of value provided the deceased did not drink this water immediately before submersion and the body is not putrefied. This water, by peristaltic movement, may enter the small intestine and provide absolute proof of death from drowning, subject to the limitations mentioned above. In dead bodies thrown in wafer, it is not possible for water to get beyond the cardiac sphincter and into the stomach and intestine. However, when putrefaction sets in, cardiac and pyloric sphincters may relax and allow water with its contaminants to get into stomach and small intestine. This observation therefore has no significance in a putrefied body.

*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.

## QUESTIONS FOR STUDENT'S INDEPENDENT WORK

1. Asphyxia. Classification of mechanical asphyxia
2. Signs of asphyxial death
3. Thanatogenesis, signs of hanging
5. Signs of strangulation by a ligature
6. Features of constriction mark at Hanging and Strangulation by a Ligature
7. Signs of manual strangulation
8. Signs of smothering
9. Signs of death at choking
10. Signs of death at compressive Asphyxia
11. Signs of death at drowning

## TESTS AND SITUATIONAL TASKS FOR SELF-ASSESSMENT

1. On forensic autopsy of a 61-year-old man the following is revealed: multiple petechias of dark red colour in the skin of the face, neck, upper third of the chest. The lung tissue on section is shining, of a carmine-red colour. The internal organs are congestive, without any visible changes and injuries; the state of blood is liquid. Identify the type of mechanical asphyxia in this case.

- A. Strangulated
- B. Obturative
- C. Drowning
- D. Lack of oxygen of inhaled air
- E. Compressive

2. On forensic autopsy of a 32-year-old man the following has been established: the presence of diffuse dark-violet post-mortem signs on legs, pelvic area, hands and forearms, acute cyanosis of the face, petechia in conjunctivas. On the neck there is a single ligature mark from downwards on the left to upwards on the right above the thyroid cartilage, dense, light brown. Microfocal haemorrhages are revealed under visceral pleura, epicardium; there is expressed venous congestion of internal organs, pulmonary oedema, oedema of brain and its membranes. These changes suggest that they are a consequence of mechanical asphyxia due to compression of:

- A. Neck by a loop at hanging
- B. Neck by a loop at strangulation
- C. Neck by extremities (strangulation by a hand, hands).
- D. Chest and abdomen
- E. Chest

3. On examination of the corpse semilunar scratches are revealed on the lateral surfaces of the neck. In a face skin, in palpebral conjunctivas there are petechias. On internal examination there are extensive haemorrhages in soft tissues of the

neck, fracture of horns of a sublingual bone, signs of asphyxial death. Identify the type of mechanical asphyxia.

- A. Hanging
  - B. Ligature strangulation
  - C. Manual strangulation (throttling)
  - D. Compression of the chest and abdomen
  - E. Closure of the respiratory tracts by a compact object
4. Which type of mechanical asphyxia presented below is usually a homicide?
- A. Drowning
  - B. Hanging
  - C. Suffocation
  - D. Ligature strangulation
  - E. Choking
5. Definite postmortem morphologic findings, typical for mechanical asphyxia except:
- A. Heavy contusion of the brain
  - B. Livores mortis is well developed
  - C. Face is cyanosed
  - D. Fluid dark red blood
  - E. Right side of the heart is full of blood

### ANSWERS

1 — E; 2 — A; 3 — C; 4 — D; 5 — A

#### **After the practical class every student should know:**

1. Clinical and morphological appearances of the different types of mechanical asphyxia.
2. Specific forensic signs of hanging, throttling, suffocation, drowning.
3. Additional methods of the diagnostics of drowning.

#### **should be able to:**

1. Diagnose definite type of mechanical asphyxia.
2. Create the section (morphological) diagnosis in cases of asphyxial death.
3. Make complete forensic conclusions in typical cases of mechanical asphyxia.



## THE RECOMMENDED AND USED LITERATURE

### **Basic:**

1. Babanin A.A. Forensic medicine: Textbook / A.A. Babanin, O.V. Belovitsky, O.Yu. Skrebova. – Simferopol, 2007. – 464 p.
2. Franchuk V.V. Forensic Medicine: practical guide / V.V. Franchuk. – Ternopil: TSMU, 2011. – 2004 p.

### **Additional:**

1. DiMaio V.J. Forensic Pathology, Second Edition (Hardcover) / V.J. DiMaio, D. DiMaio. - Boca Raton: CRC Press, 2001. – 592 p.
2. McLay W. D. S. Clinical Forensic Medicine 2E / W. D. S. McLay. – London: Greenwich Medical Media, 1996. - 336 p.
3. Jason P. Forensic Medicine: Clinical and Pathological Aspects / P. Jason, B. Anthony, S. William. - London: Greenwich Medical Media, 2001. – 832 p
4. Shepherd R. Simpson's Forensic Medicine / Shepherd R. - London: A Hodder Arnold, 2003. – 208 p.
5. Stark M.M. Clinical Forensic Medicine: A Physician's Guide (Forensic Science and Medicine): 2nd Edition / M.M. Stark – Totowa, NJ: Humana Press, 2005 - 455 p.

*Навчальне видання*

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*Методичні вказівки  
для студентів та лікарів інтернів*

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