

Ministry of Health of Belarus
Gomel State Medical University

Department of Orthopedic, Trauma and military field surgery
with the course of Anesthesiology and Critical Care Medicine

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Topic: «Local Anesthesia».

Educational and methodical development for practical training
teachers for 4th year students of medical faculty

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Methodical process is designed for self-study. It provides:

- I. relevance of the topic
- II. purpose of the lesson
- III. tasks
- IV. basic Forums
- V. Recommended Reading
- VI. Questions for students
- VII. Training Material
- VIII. Self-study
- IX. Clinical problems and test control

I. Relevance of the topic

Methods of local and regional anesthesia are still valid and a significant percentage of the overall structure of anesthesia not only in our country but also abroad. This is due to the advent of the pharmaceutical market of new local anesthetics, as well as ongoing development of methods of data allowances (neuroimaging through ultrasound and neurostimulation navigation, etc.). All these factors lead to the permanent increase efficacy and safety of analgesia while reducing the economic costs of such controls.

II. Purpose of the lesson

To study the clinical pharmacology of local anesthetics, types and methods of local and general anesthesia, indications, contraindications and complications of anesthesia techniques

III. Tasks

The student must know:

- Mechanism of action, classification, pharmacokinetics and pharmacodynamics of local anesthetics (LA);
- Anatomy of the spinal column, spinal cord, spinal nerves, nerve plexus, the nerves of the upper and lower extremities;
- Classification of methods of regional anesthesia (RA);
- The indications and contraindications for regional block;
- Advantages and disadvantages of RA
- Principles of treatment of complications of regional anesthesia

The student should be able to

- To carry out the preoperative preparation of general anesthesia;
- To reveal the situation of the peripheral nerves in the performance of the RA;
- To calculate the dose of LA when RA is performed;
- To provide intensive care to the patient with an overdose LA;
- To provide intensive care to the patient intravenously at random LA;
- Keep medical records (minutes of anesthesia) during regional anesthesia

V. Topics needed for the Classes

- Anatomy of the spinal column, anatomy and physiology of the spinal cord and spinal nerves;
- Topographic anatomy of the nerves of the upper and lower extremities;
- Pharmacology of local anesthetics;
- The structure of nerve fibers and their classification
- Physiology of nerve impulse.

Books for reading

Anatomy, Histology, normal and abnormal physiology, topographical anatomy, general and clinical pharmacology, general surgery for medical students

VI. Questions for self-preparation on basic knowledge

- The structure of the nerve fiber, the classification of nerve fibers;
- Mechanism of nerve impulse;
- Physiology of nerve impulse along the nerve fiber;
- Chemical structure of local anesthetics;
- The mechanism of action of local anesthetics;
- Anatomy of spinal and epidural space

Questions on topic:

- Local anesthetics: mechanism of action, pharmacodynamics;
- Complications of local anesthetics, their prevention and treatment;

- Types of local anesthesia: the surface, infiltration by Vishnevsky, conduction (stem, nerve plexus);
- Spinal anesthesia. Technique, indications and contraindications, complications;
- Epidural anesthesia. Technique, indications and contraindications, complications.

Topics for students

- Using of lidocaine for the treatment of arrhythmias;
- Regional anesthesia in pediatric patients;
- Combined spinal-epidural anesthesia;
- Caudal anesthesia: indications, technique, complications

Teaching tools for independent work of students

1. Computer database.
2. Objectives, test control.
3. The patients undergo different surgeries with RA.
4. Patient records and other medical documents.
5. Safety instructions, aseptic and antiseptic.
6. Independent work of students

VII. Training Material

Local anesthetics (LA)

All local anesthetics have a similar chemical structure. They consist of a lipophilic group, the intermediate ester or amide and hydrophilic amino groups. Depending on the type of local anesthetics intermediate circuit are divided into esters and amides.

Ester groups are:

1. cocaine;
2. procaine;
3. chlorprocaine;
4. tetracaine.

Amide groups include:

1. lidocaine;
2. prilocaine;
3. mepivacaine;
4. bupivacaine;
5. ropivacaine;
6. etidocaine

Mechanism of action.

Local anesthetics block sodium channels, preventing their activation and entry of sodium into the cell membrane depolarization. As a result of the action potential along the axon does not apply, because the threshold can not be reached.

LA receptors usually avoid to bind cationic form, located on the inner side of the membrane. Bound to the receptor, the cations could hardly leave the closed channels. However, for the transmembrane transport of the drug must be in unionized form.

Capacity of LA correlated with fat soluble molecule because its effect depends on the ability to penetrate the lipophilic structure. Total capacity of the LA and lipophilic increases with the total number of carbon atoms in the molecule.

Onset of action

Depend on many factors, including the relative concentration of fat-soluble molecule, and deionized water-soluble fraction of ionized LA. Although the blockade of nerve impulses involved both groups of LA through the membrane of the nerve cell and enters the neuron only fat soluble. Entering the cell, some of the molecules ionized, until a new equilibrium between the ionized and non-ionized fraction occurs. To receptors in the sodium channels interact only with ionized molecules cations. When injected into the tissue with a low pH (eg, inflammation at the injection site) deionized fraction of anesthetic increases, and for the development of the effect takes longer time.

The duration of action

Depends on the degree of binding of the local anesthetic to plasma proteins, drug absorption, metabolism and excretion

The rate of absorption of the drug is directly proportional to the vascularization of tissue at the site of injection. Therefore, regional anesthesia techniques in order to the rate of absorption: irritation of tracheal mucosa> intercostal nerve blockade> epidural> brachial plexus> sciatic nerve blockade> subcutaneous infiltration anesthesia

Vasoconstrictors. Adding to the solution of local anesthetic epinephrine, or phenylephrine, or norepinephrine (the latter two drugs are used less often) causes vasoconstriction at the injection site. Anesthetic absorption is reduced, which increases the neuronal uptake, increases the duration and reduces the severity of toxic side effects. Vasoconstrictors have greater effects on the short-acting anesthetic. For example, the addition of epinephrine to lidocaine increases the duration of anesthesia is less than 50%, but almost no effect on the duration of action of bupivacaine (long-acting bupivacaine due to the high degree of plasma protein binding).

Metabolism and excretion: Esters are hydrolyzed by pseudo-cholinesterase (plasma cholinesterase). Hydrolysis of esters is very fast, water-soluble metabolites are excreted in the urine. Amides are metabolised in the liver. Metabolic rate varies between different preparations (metabolic rate in descending order: prilocaine> lidocaine> bupivacain), but in general it is much lower in comparison with the hydrolysis of ester-type LA. Reduction of liver function (eg, cirrhosis) or liver blood flow (eg, congestive heart failure) leads to a slower metabolism and, therefore, increases the risk of systemic toxicity.

Complications of local anesthetics.

1. Toxicity;
2. Local toxicity (neurotoxicity);
3. Allergic reactions.

Toxicity. In the end, LA are absorbed from the injection site. The degree of toxicity is directly proportional to the concentration of LA in the blood. If their blood level rises significantly, the effects are developed primarily from the CNS, cardiovascular and respiratory systems

Effects on CNS: an increase in the plasma concentration of LA observed numbness of tongue and mouth, dizziness blurred vision, slurred speech, tremors, anxiety, if the concentration exceeds the critical level, can develop a large seizure. Treatment of seizures is to maintain adequate ventilation and oxygenation, the use of anticonvulsant drugs: diazepam 10-20 mg / in, or thiopental 150-250 mg / in.

Effects on the cardiovascular system: an overdose can cause severe hypotension, bradycardia, bradyarrhythmia, and even cardiac arrest, usually develops after the onset of neurological symptoms

Injection of large volumes of local anesthetic suddenly into the subarachnoid space during epidural anesthesia may lead to a "total spinal" anesthesia. Developing motor blockage of the respiratory muscles and inhibition of the medulla lead to respiratory paralysis. An autonomic nerves system blockade causes hypotension. Mechanical ventilation and support circulation (infusion, vasopressors).

Lipidrescue

LipidRescue resuscitation refers to the intravascular infusion of 20% lipid emulsion to treat severe, systemic drug toxicity or poisoning. LipidRescue was originally developed to treat local anesthetic toxicity, a potentially fatal complication of regional anesthesia that can also occur in other situations where patients receive local anesthetic injections. More recently, LipidRescue has been shown in peer-reviewed medical literature and elsewhere to be an effective antidote for poisoning or overdose caused by a wide array of other (non-local anesthetic) lipophilic agents. Initial support for this view was provided by a most remarkable case report where lipid emulsion infusion apparently saved a patient from overwhelming bupropion overdose. Since then, evidence from both laboratory models and case reports, indicates that LipidRescue can effectively in treat a wide variety of non-local anesthetic overdoses, including reversal of both cardiovascular and central nervous system (CNS) signs and symptoms of toxicity.

20% lipid emulsion: 1.5 mL/kg as an initial bolus, followed by 0.25 mL/kg/min for 30-60 minutes. Bolus could be repeated 1-2 times for persistent asystole.

Infusion rate could be increased if the BP declines.

Local toxicity (neurotoxicity)

Deposition of LA around the nerves gradually leads to an increase in their concentration to the toxic, causing permanent neurological damage. Example - "cauda equina syndrome" - repeated dose of LA (more often Lidocaine) in continuous spinal anesthesia is carried out through a small diameter catheter can cause deposition of LA structures around the nerves of cauda equina.

Allergic reactions

Allergic reactions to modern LA is extremely rare. Often observed skin reactions with repeated use of anesthetic ether, anaphylactic reactions are even rarer. Allergic reactions to amide anesthetics are even more rare

Local Anesthesia

Types:

1. terminal (surface)
2. infiltrative anesthesia
3. REGIONAL:
 - nerve blocks(plexus) anesthesia
 - spinal anesthesia
 - epidural and the lowest level is sacral anesthesia

1. Surface anesthesia is achieved by applying a solution of local anesthetic to the mucosa by lubrication, spraying, or impaling. In this case, pain sensitivity is eliminated only to the extent of the mucous membrane, which results in the possibility of operations only on it. The method is used in otolaryngology, ophthalmology, dentistry and endoscopic studies. At present, the terminal anesthesia used anesthetics of the amide group.

Infiltrative anesthesia options: Lamellar tissue infiltration at each successive stage of the operation. The method of "creeping infiltration by AV Wisniewski": after anesthesia of the skin and subcutaneous fat anesthetic is administered in large quantities in the appropriate fascial spaces of the operating area. In this way, they form a tight infiltration, which extends for a considerable distance on interfascial channels, washing them in passing the nerves and blood vessels. Wide touch nerves with LA solution provides an effective blockade. The effect of the anesthetic on the nerve pathways is evident not only at the injection site, but also on a more or less considerable distance from it.

Nerve blocks - regional anesthesia, achieved to administer the solution of LA directly to the nerve trunk or plexus nerve proximal to the operating area, which they innervate.

General rules:

1) perineural LA is introduced, when is achieved by the cessation of needle movement after the first manifestation of paresthesia;

2) to prevent intravascular injection of LA, when the punction needle is directed to the nerve, the anesthesiologist must systematically aspirate;

3) in the case of epinephrine to add it to the solution of local anesthetic the rate of 1: 200 000 immediately before the blockade;

4) Before the administration main dose (**epidural**) of LA (we must carry on the test-dose, which consist of small dose of LA with solution of epinephrine the rate of 1: 200 000 immediately before the blockade;

5) to comply strictly with prescribed concentration of the solution and not to exceed the maximum dose of anesthetic

Spinal and epidural anesthesia is called the central regional block. Physiological effects of the interruption caused by the blockade of central afferent and efferent impulses to the visceral and somatic structures. Physical structure are sensitive (touch) and motor (motor) innervation, while the visceral structures – autonomy

Spinal anesthesia is the injection of LA solution into the subarachnoid space of the spinal cord.

Indications:

- Operations on the lower extremities, hip and perineum;
- Operations on the low floor of the abdomen cavity and lumbar spine;
- Interference on the upper floors of the abdominal cavity (cholecystectomy and resection of the stomach, but it should be a high-level block

Contraindications to spinal anesthesia

Absolute:

- Sepsis, bacteremia, an infection of the skin at the puncture site;
- Severe hypovolemia, coagulopathy, anticoagulant treatment;
- Increased intracranial pressure;
- Disagreement of a patient.

Relative:

- Peripheral neuropathy, demyelinating disease of the central nervous system;
- Treatment with heparin in a "mini-dose" treatment with antiplatelet agents (except aspirin);
- Psychosis or dementia, psychological or emotional instability, lack of contact with the patient;

- Prolonged surgery, the unknown duration of the alleged interference.

Technique of spinal anesthesia: The patient is sitting or laying on the side. If the anesthetist puts his hands on the iliac wing, the thumbs are joined in the midline between the spinous processes of the LIV-LV. Puncture choose one gap where most clearly palpable landmarks, but not above the LI. The skin is treated with antiseptic directly to the puncture site, and then continue processing in a circular motion from the center to the periphery. Surgical site is closed and sterile linen removed antiseptic solution to the puncture site. At the level of the selected intervertebral gap infiltrate the skin with a solution of LA. Pushing the needle in the midline under the spinous process and parallel to it, directing it slightly cranially. After passing through the subcutaneous fat layer, the needle enters the overspinous and interspinous ligament, which feels like a drag. The second sense of resistance occurs when punching yellow ligament, and, finally, with dural puncture occurs last, the third tactile sensation - the so-called «loss of resistance». Successful puncture confirmed with free flow of cerebrospinal fluid when the mandrin is removed from the needle by the doctor. Next, we introduce the estimated dose of LA. It's about 3 ml of the LA solution.

Complications of spinal anesthesia:

- Headache: due to a defect of the dura mater, leading to a flow of cerebrospinal fluid and a decrease in its pressure. This leads to a shift down CNS structures and blood vessels that connect the dura with the skull and the brain stem. As a result, the most important factor that influences the development postpuncture headaches is the size and kind of tip the puncture needle: the larger the size of the needle, the higher the risk of pain and its intensity. Conservative treatment postpuncture headache - are within 24 hours - fluid intake (or in / infusion), analgesics inside. If these measures are not effective, you can take the epidural filling with autoblood. Epidural puncture needle is introduced into the same intervertebral space, which was performed dural puncture. Taken from a patient vein the 15 ml of himself blood and injected through the needle into the epidural space until the patient will not feel the pressure in your ears, or do not enter the entire specified amount. New treatment of headache is to appoint a caffeine IV /IM.

- Meningitis to development of specific sets of disposable needles and the incidence of meningitis decreased significantly

Damage to the blood vessels during the spinal anesthesia combine with serious complications, such as epidural hematoma due to bleeding from the epidural venous plexus. Risk factors include coagulopathy and treatment with anticoagulants.

Nerve damage during the spinal puncture needle in the subarachnoid space can come into direct contact with the elements of the cauda equina or spinal nerve roots. In order to prevent irreversible damage to the nerve should be guided by paresthesia during needle insertion.

High or total spinal blockade – is the block of thoracic segments of spinal cord and there are a high risk of severe hypotension, bradycardia, respiratory failure due to motor blocks of respiratory muscles and hypoperfusion of the respiratory center, which is situated on medulla oblongata, leading to apnea. Sleep apnea - the most common manifestation of high spinal block. Treatment of high spinal block is primarily to provide an airway and adequate circulation. When hypoventilation a helper ALV pure oxygen, with the development of apnea or loss of consciousness - intubation and forced ventilation. You can expect to bradycardia and hypotension. To stabilize blood pressure required a massive infusion, lowering the head end of the operating table and vasopressors. Ephedrine and phenylephrine are a drug of choice.

Epidural anesthesia.

In contrast, spinal anesthesia, which results in a complete blockage or complete lack thereof ("all or nothing"), and epidural analgesia on the possible options with a weak motor blockade to deep anesthesia with complete motor blockade.

Indications are basically the same as for spinal anesthesia and include:

- operations in the hip and knee joints;
- compared with general anesthesia epidural anesthesia in operations on the hip and knee joints are combined with a lower risk of deep vein thrombosis;
- bypass surgery for diseases of the arteries of the lower limbs;
- epidural anesthesia for lower extremity vascular bypass surgery is accompanied by a large increase in blood flow distal to the stenosis and occlusion of the lower incidence of postoperative vascular graft;

-postoperative period - through the introduction of epidural local anesthetic (in lower concentrations), opioids, and combinations of these drugs with other analgesics effectively eliminates post-operative pain.

Contraindications to epidural anesthesia.

The method of epidural anesthesia: After passing through the subcutaneous fat layer, the needle passes through interspinous ligament, followed by yellow ligament, passing by the needle enters the epidural space. The most common method of identification of the epidural space is the technique of "loss of resistance".

Procedure "loss of resistance": holding a needle through the skin into interspinous ligament feels like significant resistance. When the tip of the needle is in the thickness of the interspinous ligament, mandrin removed and attached to the needle syringe filled with sodium chloride solution. If you attempt to enter the solution will meet considerable resistance or can not be performed, the end of the needle is indeed in the interspinous ligament is thicker and can move forward. Needle attached to a syringe is slowly moving forward with the left hand while the right is constantly putting pressure on the plunger of the syringe. After contact with the end of the needle into the epidural space is sharply reduced resistance and piston suddenly easy to advanced.

Epidural puncture can be performed at the level of all four parts of the spine: cervical, thoracic, lumbar, sacral. The introduction of a local anesthetic into the epidural space has always starts with the injection of test dose. For this purpose, usually used 3-5 ml of local anesthetic (lidocaine) with solution of epinephrine the rate of 1: 200 000. If the test-dose fell into a blood vessel, then after a 30-60c heart rate increased by 20%. When injected into subarahnoidalnoe space for 3 minutes will develop symptoms of high spinal anesthesia.

Complications of epidural anesthesia.

Many of the complications seen with spinal anesthesia and epidural arise.

VIII. Self-study

Task 1. Identify possible interspinous spaces for safe puncture subarachnoid space.

Task 2. Develop tactics intensive care Accidental intravascular injection of LA.

Clinical tasks

Task 1.

32 years old man, with recurrent dislocation of the right shoulder, taken to the operating room for plastic capsule shoulder. The patient chose to regional anesthesia. Anesthesiologist decided to block of the brachial plexus interscalene access using his 2% lidocaine with epinephrine in a dilution of 1: 200 000. The procedure to identify paresthesia. There was a short-term paresthesia on his shoulder. After the injection of 15 mL of anesthetic patient became restless and agitated, complaining of shortness of breath. Immediately after that, the patient developed apnea and lost consciousness. What is the preliminary diagnosis? What are the expected hemodynamic effects? What measures should be taken immediately?

Task 2

Anesthesiologist performed behind the ankle unit patients undergoing amputation thumb over large nonhealing ulcers. The unit is flawless, but at the moment the patient is cut suddenly screams. Why is the inadequacy of the anesthesia? What measures should be taken?

Test control:

1. Almost practically horizontal position spinous processes of vertebrae have following:

- a) cervical and thoracic;
- b) cervical and lumbar;
- c) two cervical and all thoracic;
- d) average of the lumbar and lower thoracic.

2. The spinal cord in the adult end at the level

- a) L I;
- b) LII;
- a) Th XII;
- d) Th XI.

3. LA toxicity depends on:

- a) the concentration of LA in the blood plasma;
- b) the concentration of LA around the nerve trunk;
- c) on the osmolality of the solution;
- d) all of the answers are correct.

4. Local toxicity of LA depends on:

- a) the concentration of LA in the blood plasma;
- b) the concentration of LA around the nerve trunk;
- c) on the osmolality of the solution;
- d) All right.

5. The duration of the LA:

- a) increases when added to a solution of vasoconstrictor LA;
- b) the duration of the ester group in LA;
- c) the duration of the amide group in LA;
- d) affected by poor vascularization of tissue.

6. The onset action of LA:

- a) is faster with increasing concentration of ionized (hydrophilic) fraction;
- b) is faster increasing with concentration of non-ionized (lipophilic) fraction;
- c) the rate of onset of effect is independent of the degree of ionization, LA
- d) is faster with increasing concentration of LA.

7. LA power depends on:

- a) fat-soluble;
- b) the number of carbon atoms in the molecule;
- c) on the water solubility;
- d) the dose of MA.

8. The group of essential LA include:

- a) cocaine;
- b) lidocaine;
- c) tetracaine;
- d) bupivacaine.

9. The group amide LA include:

- a) cocaine;

- b) lidocaine;
- c) tetracaine;
- r) bupivacaine.

10. Types of local anesthesia:

- a) terminal (surface);
- b) infiltration;
- c) REGIONAL;
- d) endotracheal.

Answers of

Task 1

Abrupt decompensation of the patient suggests that when injected into the gap interscalene anesthetic is not in a fascial sheath, and other anatomical space. The proximity of the vertebral artery significantly increases the risk of intra-arterial injection, and quickly hit the anesthetic directly into the brain. But the patient developed a generalized epilepsy, which was not the case here. Other structures located behind the brachial plexus in the interscalene interval are epidural and subarachnoid space. Acute development of apnea and rapid loss of consciousness after the first complaints with high probability suggest an injection of anesthetic into the subarachnoid space. Effects: The working diagnosis is a total spinal anesthesia, so you can expect a rapid development of full medical sympathectomy with the emergence of profound hypotension. Dominated by vagal tone, resulting in bradycardia. Apnea will be long, because there was a blockage at the level of C3-C5 segments. Treatment: It is necessary to immediately stop the injection of anesthetic. Transfer the patient in the Trendelenburg position, start intravenous bolus infusion of fluids, mechanical ventilation with 100% oxygen. Before intubation, mechanical ventilation must be via a face mask because full oxygenation has temporal priority to ensure the airway. If ventilation with 100% oxygen through a mask is difficult or impossible, it should quickly perform tracheal intubation, it is quite possible, since there is no need to use muscle relaxants and hypnotics. Furthermore, it should prevent the development of sympathetic blockade: introducing holinoblokator in vagolytic doses (2-3 mg atropine) and vasopressor, such as ephedrine, 10-25 mg. If bradycardia and hypotension are not resolved immediately, then you must enter the 10-100 mg epinephrine

Task 2

local pH of the tissues surrounding the infected thumb, probably less than 7.4. Most anesthetics introduced in this area, is in the ionized form, and they are not able to penetrate the neuronal membrane. The need for more proximal peripheral nerve block or spinal anesthesia

Answer S

1 - d

2 - a;

3 - a;

4 - b;

5 - a, c;

6 - b;

7 - a, b;

8 - a, c

9 - b, g;

10 - ab, c.