Intravenous anesthetics (pediatrics)

Introduction

Intravenous anesthetics are mainly used **to introduce anesthesia** . However, since most of these substances have no or only very weak analgesic effects, they are not suitable for conducting anesthesia. They must therefore be **combined** with analgesic drugs, **especially opioids** . The advantages of intravenous anesthetics compared to inhaled anesthetics are obvious especially in the introduction to anesthesia: simple technique, fast and usually pleasant falling asleep, no significant excitation stage . On the other hand, controllability even with anesthetics is less favorable. After the injection, even the dose of the anesthetic is beyond the possibility of further influence by the anesthesiologist, while the effect of inhalational anesthetics can usually be changed within a short period of time.

Barbiturates

In clinical practice, the ultra-short-acting barbiturates **thiopental and methohexital** are commonly used to induce anesthesia quickly, smoothly and pleasantly. On the other hand, these pharmaceuticals **are not suitable for maintaining anesthesia** , because their dosage would be so high that adverse effects would occur, especially from the cardiovascular system and kidney function.

Thiopental

Pharmacological effects

- For clinical use, the substance is prepared as a water-soluble sodium salt. By adding 20 ml of aqua for injection to the dry substance in a dose of 0.5 g, a 2.5% solution is created.
- Thiopental **leads to graded CNS depression** . After a single injection, sleep begins within 10-20 seconds of rapid sleep onset. The depth of anesthesia may deepen in the first 40 seconds, but then it thins out quickly, so that **consciousness is fully restored within 20-30 minutes** .
- A deep stage of anesthesia with barbiturates can normally be achieved only with such doses that lead to a significant influence on cardiac activity, hemodynamics and respiration. Therefore , **barbiturates are not suitable as a monoanesthetic** . In addition, higher and repeated doses lead to accumulation with prolongation of anesthesia and awakening time.

Signs of anesthesia
: **are uncharacteristic** when using thiopental . The pupils are narrow or of normal size, the bulbs are most often fixed in the middle position, the lid and corneal reflexes have disappeared, the functions of breathing and circulation are negatively affected to some extent. *Subanesthetic doses of barbiturates have no analgesic effects, on the contrary, they lead to heightened sensitivity to somatic pain (hyperalgesia).

Effect on blood pressure and circulation
: Thiopental **causes a temporary decrease in blood pressure depending on the size of the administered dose** . The drop in blood pressure in otherwise healthy patients is usually very little expressed and is not clinically significant. The rate of decrease depends mainly on the compensatory increase in heart rate and peripheral vascular resistance. The drop in blood pressure is less if thiopental is administered slowly, whereas rapid injection of high doses leads to a rapid decrease in peripheral vascular resistance, resulting in marked hypotension. In addition, patients with hypertension, heart disease and hypovolemia should expect a significant drop in blood pressure. **Veins expand** under the influence of barbiturates , thereby creating venous stasis (pooling) and **decreasing venous return to the heart** .

Affecting heart rhythm
: After injection of thiopental, **the heart rate reflexively increases . Heart rhythm disturbances** , most commonly ventricular extrasystoles , may occur after administration of thiopental .

Affecting the respiratory center
: Both thiopental and methohexital suppress the respiratory center in a dose-dependent manner, the response to hypercapnia and hypoxia is weakened or even completely disappeared. After anesthetic doses, the tidal volume first increases for 2–3 breaths, but is followed by apnea. This moment coincides in time with the highest concentration of thiopental in the brain. Shortly thereafter, breathing resumes, but the depth and frequency of breathing are reduced. **The degree of respiratory depression** depends mainly on the intensity of the stimulation. Clinical significance: **cough, laryngospasm or bronchospasm may occur after iv injection of thiopental**, especially with shallow anesthesia. In deep anesthesia, on the other hand, the mentioned reactions are not observed. Bronchospasm induced by barbiturates can usually be managed by the administration of an inhaled anesthetic. Barbiturates lead to a marked induction of microsomal enzymes in the liver. This **accelerates the metabolism of numerous pharmaceuticals and endogenous substances** (steroid hormones , cholesterol , bile acids , etc.). The effect of barbiturates in acute intermittent porphyria is particularly dangerous → because the mentioned substances increase the synthesis of porphyrins, they can cause an acute attack in patients with this disease, which can be fatal.

Individual changes in kinetics
: In adipose patients, the biological half-life of thiopental is prolonged, which is conditioned by a **significant accumulation of barbiturates in adipose tissue** . In contrast, children usually wake up faster than adults even after higher and repeated doses.

Adverse effects and complications

- Accidental **intra-arterial administration of** barbiturates **results in vasospasm and severe pain** that shoots up the arm. The result can be gangrene and irreversible nerve damage. The damage is directly proportional to the size of the dose and the concentration of the injected barbiturate. Immediate measures in case of accidental intra-arterial administration: administration of 1/1 FR into the affected artery followed by administration of vasodilatory effective lidocaine , some authors also recommend administration of a small dose of heparin as well .
- A rare complication of barbiturate administration is **excitatory manifestations** - tremors, muscle tremors and hypertonia. Rapid administration probably increases the risk of developing and developing the above symptoms.
- **Allergic reactions** to barbiturates occur especially in patients with asthma, urticaria and similar diseases, but in general allergic reactions are **very rare** .

Clinical use

Thiopental leads to a modified general anesthesia in which the state of sleep is marked - a hypnotic effect without an analgesic component. Therefore, thiopental is exclusively **used to introduce general anesthesia** , further **to supplement nitrous oxide in short procedures or as a monoanesthesia in very short and painless procedures** , such as cardioversion or electroshock therapy. **Contraindications** to thiopental are the following diseases:

- status asthmaticus and conditions associated with bronchospasm;
- allergy to barbiturates;
- decompensated heart failure ;
- severe hypovolemia or shock;
- acute intermittent porphyria .

For introduction to anesthesia with ultra-short-acting barbiturates, premedication given at the right time plays an important role. **In** well- **premedicated patients , fewer side effects and adverse effects** occur during administration . However, the occurrence of barbiturate side effects also depends on the size of the dose and the speed of its administration

Dosage

- **sedative dose** : 1–2 mg/kg iv;
- **induction anesthetic dose** : 2–5 mg/kg iv, for small children 4–6 mg/kg iv;
- **onset of effect within 30 seconds ;**
- **duration of effect 5-10 minutes** .

Doses of thiopental **must be appropriately reduced in the following situations** :

- severe disorders of liver and kidney function;
- hypovolemia;
- anemia ;
- bleeding;
- respiratory insufficiency ;
- cachexia ;
- striated muscle diseases;
- hypothyroidism .

Thiopental is administered bolus = from the hand smoothly, not too quickly, until the lid reflex disappears within a time range of approx. 30 seconds.

Practical procedure during introduction to anesthesia

1. First of all, it is necessary to put the necessary anesthesia equipment into functional readiness.
2. We put the patient's head in the "sniffing" position and ask the patient to calmly inhale the pure oxygen administered through the mask for a few minutes.
3. Thiopental is injected continuously until the eyelid reflex disappears.
4. After falling asleep, we ensure patency of the upper respiratory tract with Esmarch's triple palpation , in case of insufficient breathing or respiratory arrest, the patient is breathed through a bag through a mask.
5. During mask anesthesia, after falling asleep, a mixture of oxygen with nitrous oxide and a potent inhalation anesthetic, possibly breathing is temporarily supported and then the patient is already capable of sufficient spontaneous ventilation.
6. In anesthesia with tracheal intubation , an intubation dose of myorelaxant IV is given after the initial sedative dose, and after the onset of the maximal effect of the relaxant, the patient is intubated. Anesthesia is continued with a mixture with an inhalation anesthetic or with a combination of opioid - N 2 O - oxygen.

Etomidate

Etomidate (Lipuro, Hypnomidate) is a potent and fast-acting hypnotic without an analgesic component. The substance is used as an induction preparation to **introduce anesthesia and to supplement other substances** , such as opioids. The margin of safety is large and adverse effects on breathing and blood circulation are small.

Pharmacological effects

- The company preparation Hypnomidate (Janssen) contains the active substance as a ready-made solution of 10 ml in 1 ampoule, i.e. 1 ml of solution contains 2 mg of etomidate, 1 ampoule contains 20 mg of the active substance. The active substance is in a fat emulsion. Its main advantages are less irritation of the vein wall and practically no local pain at the injection site.
- Etomidate **has a depressant effect on the reticular formation** of the brainstem. After iv injection of the initial dose , **sleep sets in within 1 minute** , and in 2-3 minutes after bolus administration, all patients are amenable again. The duration of sleep depends on the size of the dose and increases with increasing dose. After a single, comparably effective dose, the duration of sleep is shorter than after thiopental. However, the duration of the awakening phase depends mostly on the size of the administered dose.
- Etomidate **has no analgesic properties** , it is exclusively a potent hypnotic. **Painful procedures cannot be performed in monoanesthesia with etomidate** , even if the highest doses were used.

Etomidate has the least effect on the heart and hemodynamics of all the anesthetics used. **Respiratory depression is minimal** , but potentiation by opioids can lead to prolonged postoperative respiratory depression.

- Etomidate is **biotransformed rapidly, mainly in the liver .**

Adverse effects

Pain at the injection site is relatively common with the administration of current preparations, as with propofol. The most significant adverse effect is apparently **involuntary muscle movements** and, in a small part of patients, **cough and hiccups** . Another disadvantage is the **lack of analgesic effect and insufficient attenuation of reflex reactions .**

Clinical use of etomidate

- Etomidate is used **in the introduction to anesthesia, especially in cardiopulmonary risk patients** . In practical use, the side effects of etomidate (see above) are eliminated by the simultaneous administration of opioids. **Continuous infusion** of etomidate **is not recommended** due to the inhibition of cortisol synthesis .
- Specific contraindications for etomidate are currently unknown.

Dosage

The safety margin of etomidate is very considerable, the substance can hardly be called an overdose.

- **Dose for induction of anesthesia** : 0.15–0.3 mg/kg iv

Practical procedure during introduction to anesthesia

- First, the same preparation as described for thiopental is carried out.
- We then administer a low dose of opioids, e.g. fentanyl 0.05–0.1 mg IV approximately 5–7 minutes in advance in titration form (blocks the occurrence of myoclonus and dyskinesias).
- This is followed by an injection of an individually determined dose of etomidate.

Propofol

Propofol (Diprivan) is a **fast and short-acting hypnotic without analgesic potency** . It is mainly used for the introduction to anesthesia, but it can also be used in principle during the ongoing administration of anesthesia with the addition of opioids. It is **often part of exclusively intravenous anesthesia** .

Pharmacological effects

- The preparation Diprivan contains the active substance in an emulsion of oil in water, i.e. in a form similar to the prepared fat emulsions for intravenous infusions. It is intended for IV administration. 1 ml of injectable substance contains 10 mg of propofol. The substance is also **administered in the form of a bolus** . A 2% solution in 50 ml infusion bottles is available for infusion. Always shake the ampoule properly before use.
- Propofol leads **to unconsciousness within 25–40 seconds** , which **lasts an average of 4–8 minutes** . Similar to other induction agents, propofol has no analgesic properties.
- Changes in heart rate are less pronounced after propofol than after thiopental. Most of the time, the **heart rate will increase slightly** . Patients with chronic β-blocker medication , on the other hand, are often prone to significant bradycardia with continued infusion of propofol. The drop in blood pressure after administration of propofol is slight, significant only in patients with cardiac limitations. Propofol **leads to a decrease in cardiac output** , probably due to a negative inotropic effect. This consequence is also more pronounced in patients with cardiac limitations.
- Propofol **after iv injection leads to transient apnea lasting about 1 minute** in the vast majority of patients .
- Propofol is a short-acting preparation that is also suitable for continuous infusion administration. It is largely **conjugated in the liver and the metabolites are excreted by the kidneys** .

Clinical use of propofol

Propofol is mainly used **to induce anesthesia** . Continuous infusion can be the hypnotic component of modified, exclusively intravenous anesthesia with opioids and nitrous oxide or completely without N 2 O (TIVA). The advantage of propofol is **pleasant falling asleep and waking up, post-anesthetic nausea and vomiting** occur only **rarely** , on the contrary, it even has a certain antiemetic potency compared to other anesthetics. **It does not release histamine** . The awakening phase is characterized by less oversleeping, perhaps a slight euphoria.

Adverse effects

Decrease in blood pressure in cardiac limited patients, transient apnea, **pain at the injection site** - probably the most common side effect. Excitation phenomena can sometimes be observed, but myoclonus does not occur.

Dosage

- sedative dose: 1–2 mg/kg iv;
- induction dose: 1.5–2.5 mg/kg iv, in young children 3–4 mg/kg iv;
- continuous infusion administration: 1–5–12 mg/kg/hour;
- dosage for TIVA with opioids: 2–4–6 mg/kg/hour. iv (high variation width);
- continuous sedation: 25–75 ug/kg/min.

The rate of administration should be approximately 20 seconds for a bolus induction dose.

Practical procedure during introduction to anesthesia

The practical procedure for induction of anesthesia is the same as for thiopental (see above).

Ketamine

Ketamine (Narkamon, Calypsol) is a typical representative of a **dissociative anesthetic** . It is most often used as a monoanesthetic **for minor surgical procedures** , rarely as an induction agent for general anesthesia.

Pharmacological effects

Ketamine induces **" dissociative anesthesia "** , a type of cataleptic state in which the patient appears to be completely disconnected from his surroundings without entering a state of normal sleep. The condition is characterized by marked analgesia and amnesia. * **Analgesic action** is more pronounced against somatic pain than against pain of visceral origin. In about **20-60 seconds after IV administration, the patient loses consciousness** . With the onset of loss of consciousness, the eyes open wide and both horizontal and vertical **nystagmus appear** . After another few seconds, the eye movement stops and the bulbs are fixed in the middle position. Blinking, eyelid and corneal reflexes and laryngeal reflexes are mostly subdued, **muscle tone is increased**. The patient is pharmacologically completely disconnected from his surroundings. However, the classic signs of general anesthesia of the associative type are absent. **Involuntary muscle movements** often appear , or **grimacing and vocalizations** . Central excitation manifestations cannot be influenced by premedication. The effects of ketamine often induce **bizarre dreams and optical hallucinations . They can be alleviated by premedication with a benzodiazepine** such as midazolam before ketamine administration.

- The onset of effect is usually within 60 seconds, duration 10-20 minutes. With IM administration, the effect begins within a few minutes, with rectal administration in approx. 10-15 minutes.
- Repeatedly administered additional bolus doses prolong the duration of the effect.
- Ketamine is the only anesthetic that **has a stimulating effect on the cardiovascular system** . Tachycardia and hypertension rates vary significantly from patient to patient.

Contraindication
: Ketamine is **contraindicated in people with coronary heart disease** .

Effect on breathing
: Depending on the size of the dose, ketamine can also cause temporary respiratory arrest. Concomitant administration of low doses of benzodiazepines usually does not result in respiratory depression, but high doses can cause significant depression. The muscle tone of the upper airways is well maintained even under the influence of ketamine, the same applies to the protective reflexes of the large airways. Nevertheless, **aspiration is considerable in non-fasting and non-intubated patients .**

After administration of ketamine, **the secretion of salivary glands and mucous cells of the mucous membrane of the tracheobronchial tree increases** considerably . Therefore, it is **advisable to combine** ketamine **with** premedication with **a small dose of atropine** . It should be taken into account that this combination will potentiate the rise in heart rate.

- **The tone of the striated muscles is increased** . Rarely, muscle rigidity with stiffening of the muscles of the lower jaw can occur - this can be canceled by administering a muscle relaxant or inhaling a potent inhalation anesthetic.
- Ketamine **does not increase plasma histamine** levels.

Demolition
: takes place **in the liver** . Halothane and diazepam prolong the action of ketamine.

Clinical use of ketamine

The main indication for ketamine is **minor surgical procedures on the body surface** . Rectal administration can be used for uncooperative children. The stimulatory effect on the cardiovascular system and hemodynamics predisposes ketamine to analgesia **in patients in shock** .

Contraindications

- systemic hypertension ;
- cardiac insufficiency ;
- pheochromocytoma ;
- hyperthyroidism .

Relative contraindications include :

- intracranial hypertension ;
- epilepsy .

Dosage

- analgesic dose: 0.2–0.5–1 mg/kg iv, 3–5 mg/kg pr;
- induction dose: 1–3 mg/kg iv, 5–12 mg/kg im, other doses are half the starting dose.

Practical procedure

- For anesthetic doses, it is advisable to administer atropine in a dose of 0.02 mg/kg in premedication. When administered on its own, a **combination with benzodiazepines is suitable** , either with midazolam at a dose of 0.1–0.15 mg/kg iv or for longer action with diazepam at a dose of 0.2 mg/kg iv
- After anesthesia with ketamine, we place the patients in a quiet environment with a minimum of possible stimuli, we **do not disturb the children or talk to them** .

Links

Related Articles

- Anesthesia (pediatrics)
- Inhalation anesthesia
- Neuroleptics (pediatrics)
- Benzodiazepines (pediatrics)
- Opioids (pediatrics)

External links

Source

- HAVRÁNEK, Jiří: *Anesthesia in children* .