



Inhalation Anesthesia: Technical Information and Inhalant Anesthetics

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Summary: General anesthesia in cats and dogs is the factor that directly affects the quality and comfort of the surgery. Inhalation anesthesia is an anesthetic technique that has been successfully used in veterinary surgery in recent years. Anesthesia complications can be reduced to minimum level with this anesthesia technique. The patient's introduction to anesthesia and recovery time from the anesthesia goes on without any problem. Inhalation anesthesia technique is more successful and advantageous than other techniques. However, equipment and used drugs are not economical. In this review the latest information about the technique of inhalation anesthesia and used drugs to provide general anesthesia in cats and dogs was evaluated.

Key words: Inhalation anesthesia, inhalant anesthetics, technical information

İnhalasyon Anestezisi: Teknik Bilgi ve İnhalant Anestezikler

Özet: Kedi ve köpeklerde genel anestezi; yapılacak olan cerrahinin kalite ve konforunu direk etkileyen faktördür. İnhalasyon anestezisi veteriner cerrahide son yıllarda başarılı bir şekilde kullanılmaya başlanmış bir anestezi tekniğidir. Anesteziye bağlı komplikasyonlar bu anestezi tekniği ile minimum seviyeye düşürülebilmektedir. Hastanın anesteziye girişi ve anesteziden uyanışı sorunsuz bir şekilde olmaktadır. İnhalasyon anestezisi tekniği diğer tekniklere göre daha başarılı ve avantajlıdır. Ancak ekipman ve kullanılan ilaçlar ekonomik değildir. Bu derlemede; kedi ve köpeklerde genel anestezi sağlamak için uygulanan inhalasyon anestezisi tekniği ve kullanılan ilaçlar hakkındaki son bilgiler değerlendirilmiştir.

Anahtar kelimeler: İnhalant anestezikler, inhalasyon anestezisi, teknik bilgi

Introduction

Inhalation anaesthesia is a popular and reasonably safe technique for providing anaesthesia for surgery and medical diagnostic procedures (7,8). Inhalation anesthesia is one of the anesthesia method which provides general anesthesia. This type of anesthesia is applied easily in all animal species. With inhalation anesthesia, gas anesthetics are given directly to the respiratory system by vaporizer which is mounted to the anesthesia machine. To provide the general anesthesia anesthetic agents should be penetrated to the alveolar epithel, distributed with the blood and reached to the brain (3,5,13).

Inhalation agents produce anaesthesia via their effects in the central nervous system. Depth of anaesthesia depends upon the concentration of the agent in the brain. A better term than concentration would be partial pressure or tension, because these agents are gaseous, and we usually measure their concentration in units of pressure (8,14).

The inhalation and elimination of the anesthetic agents which are used in inhalation anesthesia are

rapid and depth of anesthesia can be controlled. The patient should be monitored during the anesthesia (2,9,12).

Inhalation anesthesia should be particularly preferred for the surgical operations which last more than 60 minutes. Many of the injectable anesthetic agents provide same duration of anesthesia. Anesthesia quality decreases in the case of extension of the anesthesia by additional doses. But with the inhalation anesthesia, because the depth of anesthesia can be controlled these kind of complications are not occurred (1,15,18).

In this anesthesia method, the anesthetic agent is given to the patient by mask or endotracheal intubation (18). For the short duration of surgical operations, the continuance of anesthesia can be provided easily by the inhalation anesthetic agents which are given by mask to the patients who are not intubated (13,15). Inhalation anesthetic agent combined with O₂ are inhaled to the patient by the tubes of inhalation anesthesia machine. In this technique expiration air is not inspired again. Therefore, high rate of gas flow is required. It is the disadvantage of this technique to apply over dose anesthetic agents (4,14,16).

In the technique of endotracheal intubation, endotracheal tubes are used (2,12,15). The anesthetic agent combined with O₂ is administered to the lungs by the endotracheal tube which is connected to the anesthesia machine. In this way, secure and stable anesthesia is provided by less dose of anesthetic agent. Intubation is the placement of endotracheal tubes into the trachea. For this procedure premedication is essential. For induction, short term injectable anesthetic agents are applied (ketamine, propofol, thiopental sodium) (8, 18).

For high dosage of inhalation anesthetic agents the mask technique can be used for induction. With the assistance of a laryngoscope, an endotracheal tube which is correct for the diameter of trachea is passed through the oropharynx, glottis, and larynx into the trachea (13). For possible complications of larynx edema or irritation local anesthetics are applied to the endotracheal tube or larynx (12). Endotracheal tube cuff is inflated by an injector. It should be certain that the tube is placed into the trachea (5). A cervical collar is sometimes used to prevent motion of the airway. Tube placement should be confirmed after each inspiration-expiration movements of the patient. If there is no spontaneous respiration after the pressure to the thoracic cage, motion of the airway can be confirmed. After the intubation endotracheal tube is placed to the anesthesia machine (4,17).

When the anesthesia process is done, vaporizer is closed and O₂ is administered to the system. When the spontaneous respiration of the patient is normal, proximal end of the tube is removed from T-piece of the anesthesia machine. When the recovery from anesthesia begins and glottis reflex occurs the air in the high-pressure cuff is released by an injector and tube is removed from trachea. This is referred to as extubation of the trachea (12,13).

Breathing systems

The circle breathing system is the most common circuit used and is standard equipment on most anesthesia machines. Pediatric, standard adult (small animal), and large animal circuits differ primarily in their internal diameters, rebreathing bag, and overall volume and size of the carbon dioxide absorbent canister. Pediatric and adult circuits have the same size absorbent canister and differ only in the size of the breathing tubes and rebreathing bag used (9).

Nonrebreathing systems have no chemical absorbent and depend on a high fresh-gas flow rate to remove exhaled CO₂ from the breathing system. They are less efficient than the rebreathing system; the oxygen and anesthetic agent are wasted; more anesthetic agent must be scavenged, with a greater potential for environmental contamination; and patient heat and humidity is not conserved, so that patient cooling due

to convective heat loss is greater (8,9).

Ideal inhaled anesthetics

- Should not have an irritating and unpleasant smell.
- Should provide a quick induction and rapid recovery from anesthesia.
- Should provide good analgesia, muscle relaxation, quick changes and easy maintenance of anesthesia for the surgical access.
- Should be secure and provide emergence from anesthesia and should be monitored easily.
- Should cause minimum complications.
- Should not have any toxic effect.
- Biotransformation level of the agent should be low.
- Should be easily and cheaply obtained.
- Should not be explosive.
- Should not be decomposed during retention period.
- Should be used safely with other medications.
- Should dull the reflexes.

According to the researches up till now, it is not mentioned that there is a precisely ideal anesthetic. Therefore, with minimal effect on the cardiovascular and respiratory systems, non-toxic effect of volatile anesthetics should be used. Currently used inhalation anesthetics isoflurane, sevoflurane and desflurane (7,11).

Isoflurane

Isoflurane can be used in all animal species. The blood/gas coefficient is 1.4. Therefore induction, recovery from anesthesia and metabolism of the agent occur quickly. This indicates the minimum toxic effect of isoflurane. Its own vaporizer (Isotec) is used (17). Induction of anesthesia can be achieved by using 2,5 to 4.5 % enflurane in air or in oxygen, and prolonged with 1 to 3 %. To prevent depression of the respiratory system and irritation of the respiratory tract premedication is suggested. In spite of its side effects on respiratory system its prevention on bronchial vasoconstriction is considered as an important advantage. Therefore isoflurane is suggested in patients with bronchospasm (9,19). 0.2 % of isoflurane is metabolized (2). This is considered as an important advantage of isoflurane. Isoflurane does not have any functional or pathological effects on kidneys. Therefore it can be used safely in patients with kidney problems (6,7,11).

The different levels of liver function tests during

anesthesia returns to the reference levels after recovery. Because isoflurane has a minimum effect on liver and hematologic parameters compared with other volatile anesthetics it can be safely used in patients with liver failure (1,2).

Isoflurane does not contain preservatives and is not broken down by sunlight. Isoflurane has a pungent odor and tends to cause breath holding in non-premedicated animals. Depresses cardiovascular (reduction in cardiac output and induces vasodilation) and respiratory (reduces respiratory rate and tidal volume) functions in a dose-dependent manner (3,16,19). Isoflurane is approximately 7-8 times less expensive than sevoflurane (2). The close similarity in vapor pressure between halothane and isoflurane allows isoflurane to be administered in a halothane vaporizer, once the halothane preservative (thymal) has been properly cleaned from the vaporizer (1,17)

Sevoflurane

The blood/gas coefficient is 0.59. Therefore it provides quick induction and recover. Must be used with a vaporizer designed specifically for sevoflurane (Sevotec). When 5% sevoflurane is administered for induction, anesthesia occurs in 2 minutes, and is prolonged with 1 to 4% (7,10,11).

Sevoflurane has a high alveolar concentration which provides a quick equilibrium in the blood and brain. Anesthesia recovery period is quick and calm. Therefore for the long duration of surgical operations sevoflurane is preferred. Sevoflurane is metabolized by the liver microsomal enzymes and the rate is 2%. With isoflurane it is 0.2% (2,8,18).

Sevoflurane has a lower blood gas solubility than isoflurane, resulting in a faster induction of anesthesia, changes in depth of anesthesia, and recovery from anesthesia. Sevoflurane is slightly less depressive on ventilation than isoflurane (14).

The anesthetic index is the apneic inhalant anesthetic concentration divided by the MAC. The anesthetic index of sevoflurane in dogs is 3.45, while the index of isoflurane in dogs is 2.61. This indicates that sevoflurane is less likely to inhibit respiratory function than isoflurane at equal anesthetic concentrations (10).

Sevoflurane has similar cardiovascular sideeffects to isoflurane; both inhalants cause dose-dependent cardiovascular depression. It is less potent than isoflurane and is minimally metabolized by the liver and kidneys. Sevoflurane is more expensive than isoflurane. It may react with desiccated soda lime, causing chemical instability and heat production (2,5).

Desflurane

Desflurane is It requires the use of electrically heated

vaporizers. Desflurane has a very high vapor pressure and therefore requires a special temperature-controlled, pressurized vaporizer to deliver an accurate anesthetic concentration to the patient (7,11).

The temperature-controlled, pressurized vaporizer must be plugged into an electrical outlet to supply exogenous heat to the vaporizer during operation (8).

Because it's blood/gas coefficient is very low (0.42) it provides the quickest induction and recovery. However, the anesthetic effect of desflurane is lower than other volatile agents. This is considered as a disadvantage for surgical operations (13).

Desflurane is the least potent of the modern anesthetic gases (apart from nitrous oxide) with a MAC of 7.2 % in dogs. It has similar cardiovascular effects to isoflurane. Desflurane is limited in the veterinary practise (7).

Anesthetic machine

Basic components of an anesthesia machine include a compressed gas source, pressure-reducing valve (pressure regulator), flowmeter, and vaporizer. Compressed gas sources are oxygen and N₂O. While N₂O commonly is used in human anesthesia, use in veterinary medicine is limited mainly to dogs and cats to spare requirements for the more potent inhalant agents (12).

In addition to liquid bulk tanks for oxygen, sources include large tanks connected by high-pressure, color-coded (green for O₂, blue for N₂O) hose known as DISS (diameter index and safety system) and small tanks which may be connected, via a hanger yolk with a self-contained pressure regulator and pressure gauge, directly to a small animal machine (9).

Pressure regulators reduce the pressure exiting the compressed gas source to a constant and safe pressure of 50-60 psi to provide a constant pressure to the flowmeter. Flowmeters control and indicate the rate of flow of oxygen and N₂O delivered to the common gas outlet or through an out-of-system vaporizer. Gas moves from bottom to top around a float, which indicates flow rate in L (or ml)/min. Most flowmeter floats are cylindrical and read in the middle; alternate-shaped floats are read at the top. Flowmeters are calibrated at 20°C and 760 mmHg. Flow knobs usually are color coded and oxygen flowmeter knobs usually are larger than other knobs on the machine to minimize human error.

Vaporizers deliver a controlled concentration of potent inhalant to the patient breathing system. Currently, the safest vaporizers are out of (breathing) circle (VOC; Figure 5-2), precision, agent specific, concentration calibrated, and variable bypass, which are temperature, flow, and back-pressure compensated. Because vaporizers different than those just

described remain in use in veterinary practice, we provide a brief review of these (8,12).

Paired one-way valves (inspiratory and expiratory), which prevent rebreathing of exhaled gases before they pass through the absorbent canister.

Fresh gas inlet (site of entry of gases from the common gas outlet).

Pop-off (relief) valve, which vents gases to the scavenger system and prevents excessive ressure within the system.

Rebreathing bag, which provides peak demands during inspiration, a mechanism for manually assisting ventilation, and a method for observing spontaneous ventilation.

Pressure manometer, usually attached at absorbent canister and calibrated in cm H₂O to assess pressure achieved during assisted ventilation.

The absorbent canister is filled with either soda lime or barium lime granules (calcium hydroxide is the primary component of both), which neutralize exhaled CO₂. The reaction is exhaustive and produces a change in the granules, including heat generation, soft to hard, and a color change (most often white to violet). As a general rule, absorbent granules should be changed after 6-8 hr of use or when the color reaction is apparent in approximately (12).

Result

The surgery in veterinary medicine is highly developed. Operations using advanced techniques have increased. Therefore, the duration of operation was prolonged and quality anesthesia techniques were preferred. There are many problems in general anesthesia provided by injectable anesthetics. Inhaled anesthesia is a preferred anesthetic technique in veterinary surgery in recent years. Technical information and qualified staff are needed for the anesthesia equipment's using. The anesthetic drugs used in inhalation anesthesia are more expensive than injectable anesthetic drugs. Complications are less common in inhalation anesthesia. Anesthesia and recovery time from anesthesia are very fast and comfortable. As a result, inhalation anesthesia is an ideal anesthetic technique and its use is very widespread. For this reason, many veterinary clinics prefer this anesthesia technique.

Referance

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