A Therapeutic Approach in Cardiac Patients to Induce Anesthesia – a Brief Review

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Abstract

1.Background/Objectives: Anesthesia is an important achievement of modern medicine, which ensures the quality of life of patients and also provides additional comfort, safety, and accuracy to specialists. Cardiac disorders are one of the leading causes of morbidity and mortality worldwide. Anesthesia in cardiac patients is intricate and needs careful analysis. This study aims to analyze the anesthetics used in cardiac patients, with a focus on the induced side effects. 2.Methods: The present review analyzed papers retrieved from PubMed, ScienceDirect, and Google Scholar, following the keywords: "general anesthetic", "local anesthetic", "analgesic", "sedative", "side effect" and "cardiac effect". 3.Results: The term opioid-free anesthesia has been introduced around for a while. Lidocaine, ketamine, and dexamethasone are the three popular non-opioid analgesics used in cardiac surgery. The effects of midazolam, etomidate, and dexmedetomidine on the cardiovascular system during the phacoemulsification process using local topical anesthesia are also confirmed. Other studies have shown the cardioprotective benefits of propofol, in addition to anti-inflammatory properties. 4.Conclusion: Cardiac pathology is a constantly evolving problem that requires the involvement of anesthesia, therefore it is essential to know the particularities of anesthetic drugs in the case of these subjects.

Keywords: anesthesia, cardiac disorder, anesthetic drugs, side effects

INTRODUCTION

The introduction of anesthesia in modern medical sciences is considered one of the prominent achievements of the development in the medical field [1]. Anesthesia is a medical status induced by the administration of drugs causing a temporary loss of sensation or awareness. It is usually used for medical procedures and surgeries to prevent pain and discomfort. The first general anesthesia induced by inhaled ether was used during an operation procedure performed by William Morton [1].

Numerous recent studies have investigated the mechanisms behind general anesthesia, highlighting that the various behavioral responses are associated with its specific implications in different brain areas and molecular targets [2,3]. Remarkably, the binding sites of general anesthetics are closely linked to ion channel receptor functional sites. Among the various ion channels, the γ-aminobutyric acid type A (GABAA) subunit receptor is recognized as playing the most crucial role as a functional site for general anesthetics [1,4,5]. Figure 1 presents the classification of the commonly used anesthetic drugs with the induced mechanism and the main representants.

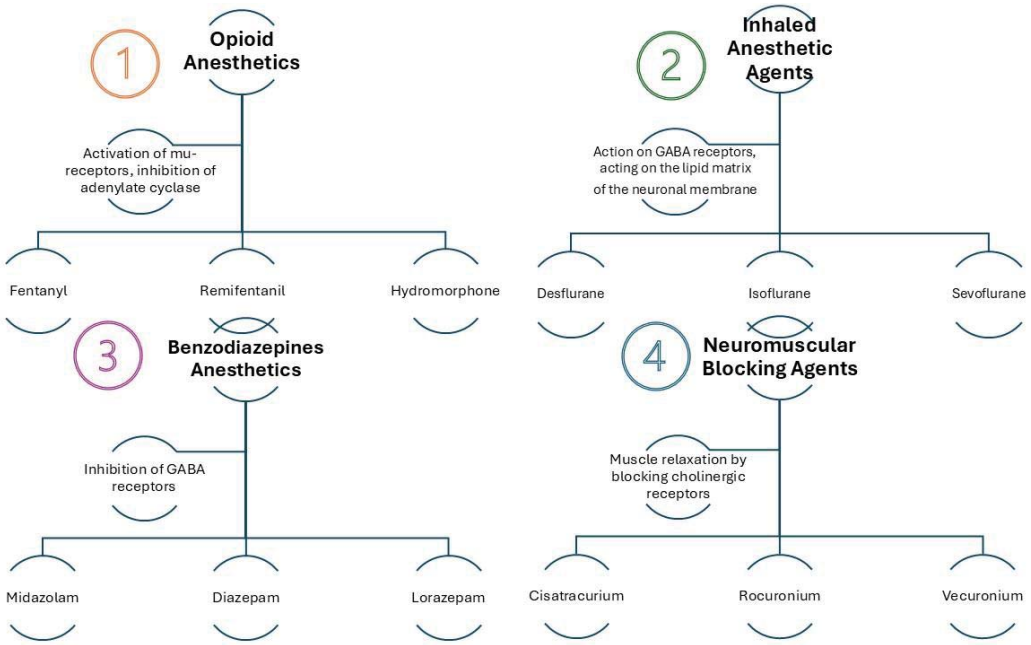

Figure 1. Anesthetic classification, mechanism of action, and representatives

Anesthetic drugs act on the nervous system, circulation, and metabolism, and thus could induce different side effects depending on the type of anesthesia used (general, regional, or local). Most effects are easily manageable and temporary, but some can induce severe disorders, especially in high-risk patients. Opioid drugs remain the most potent medication used to manage severe pain. In the case of these drugs used in acute pain settings, nausea, vomiting, pruritus, and dizziness are well-known adverse effects, which can retard recovery and even induce harm to the patients, especially bradycardia, respiratory depression, and deep sedation [6]. In the case of chronic use, considerable social issues like misuse, abuse, and unintentional deaths from overdoses were noticed [7].

Cardiac disorders are one of the leading causes of morbidity and mortality worldwide. Anesthesia in cardiac patients is intricate, needing the careful analysis of the general

anesthetic's fundamental goals with the requirement to ensure hemodynamic stability, protect organs, and preserve myocardial function.

Aim and objectives

For this reason, the use of anesthetics is challenging, so this study aims to analyse the anesthetics used in cardiac patients, with special emphasis on the induced side effects.

MATERIAL AND METHODS

The present review analyzed published papers retrieved from PubMed, ScienceDirect, and Google Scholar. The relevant research articles published online in English were selected. The searching was carried out by using the following terms or combinations: "general anesthetic", "local anesthetic", "analgesic", "sedative", "side effect" and "cardiac effect". Selected articles were chosen by title, abstract, and text relevance. Their bibliographies were analyzed too for additional references.

ANALGESIA IN HEART SURGERY

Analgesia, numbness, muscle relaxation, and amnesia are all symptoms of the administration of anesthetic drugs, characterized by full-body numbness. There is currently no gold standard method for using anesthesia in the case of heart surgery. For this reason, the anesthesiologist's professional experience and the patient's pathophysiologic state will determine the drug combination employed. Hypnosis, amnesia, analgesia, and muscular relaxation are the most critical components of current procedures that make up general anesthesia. Different factors, such as physiology, the patient's age, co-morbidities, type of operation, and other medical conditions, direct the selection of substances and doses. Both intravenous administration and inhalation are acceptable methods after induction for ensuring the maintenance phase of anesthesia [8]. The frequent reactions observed after anesthetic medication administration are presented in Figure 2.

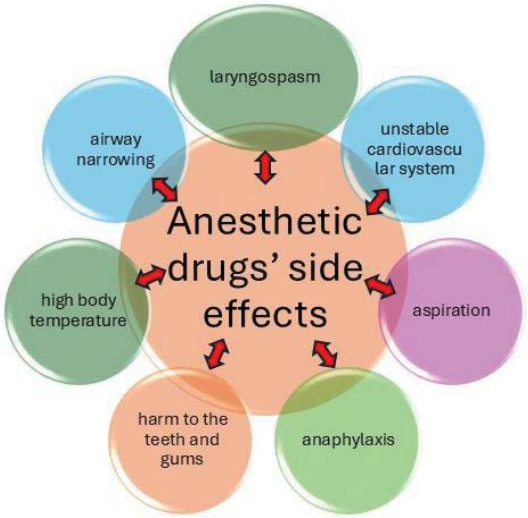

Figure 2. Consequences of general anesthesia

The term opioid-free anesthesia has been introduced around for a while. Lidocaine, ketamine, and dexamethasone are the three most popular non-opioid analgesics used in cardiac surgery. Murphy et al. highlighted that the administration of dexamethasone may reduce morphine consumption and duration of stay in the intensive care unit [9]. Different studies indicated that ketamine could reduce the need for opioids and alleviate pain. Both

non-cardiac and cardiac surgeries have shown that lidocaine can also effectively diminish pain and reduce the need for opioids [10-12].

The effects of midazolam, etomidate, and dexmedetomidine on the cardiovascular system during the phacoemulsification process using local topical anesthesia were followed by researchers. The randomized, double-blind study included 90 subjects treated with phacoemulsification as a candidate for cataract surgery. One group was given 1 μg/kg of dexmedetomidine for 10 min, followed by an infusion of the drug at a rate of 0.5 μg/kg/h. Another group was treated with a gradual intravenous injection of 0.2 mg/kg of midazolam, and the other 2 groups were administrated 0.05 mg/kg of the drug. The sedation levels, their vitals, and any side effects were always monitored. It was observed that all the drugs produced comparable levels of sedation. However, researchers affirmed that in terms of maintaining stable blood pressure and pulse rate, etomidate seemed to be more suitable than the other two drugs [12].

Other studies have shown the cardioprotective benefits of propofol, in addition to anti-inflammatory properties and downregulation in the production of inflammatory mediators. Propofol has diverse anti-inflammatory advantages when used during open-heart surgery, especially before aortic cross-clamp release in the case of patients having elective coronary artery bypass grafting surgery. At the myocardium level, it can downregulate the effect of lipid peroxides, significantly minimize the probability of an inflammatory reaction as a significant reaction to myocardial reperfusion, and limit the inflammatory cascade [13,14].

Ketamine is another protagonist able to decrease neuronal cell loss in the cortex by stopping apoptosis and excitotoxic damage during cerebral ischemia. The drug has the potential to ensure stable cerebral perfusion pressure through the activation of the sympathetic nervous system and reduces the need for vasoactive medicines after a cardiopulmonary bypass. Other neuroprotective effects of ketamine may be due to its potential to reduce systemic inflammation after surgery [15]. In addition, it can reduce postoperative delirium after heart surgery with a cardiopulmonary bypass graft. Moreover, cardiac surgery is related to an augmented risk of postoperative cognitive dysfunction. Ketamine can protect neurons by lessening inflammation and excitotoxicity observed after cerebral ischemia. It can reduce postoperative cognitive dysfunction one week after heart surgery, a property that may be due to the drug's anti-inflammatory potential [16]. The most common drugs used for anesthesia reasons and their side effects are related in Table 1.

Table 1. Common Anesthesia Drugs and Their Side Effects

Drug's name	Therapeutic effect	Side effects	Reference
Remifentanil	A synthetic opioid short-acting, potent analgesic. In addition to the anesthetic action, it is administered to patients to reduce discomfort during surgery.	fast onset of bradycardia, quick respiratory depression, confusion, blurred vision, dizziness, chest pain and discomfort, faintness or lightheadedness, nervousness, sweating, unusual weakness or tiredness, and headaches.	[17].
Morphine	Opioid pain liberator, it is is given to patients with severe pain not responding to other painkillers.	Reduction of the the cardiac output and pulse rate, depressing the myocardium, chest pain, blurred vision, dizziness, confusion, respiratory depression, nervousness, headaches.	[18].
Isoflurane	A liquid inhalation anesthesia used by vaporizing, acting on the lipid matrix of the neuronal membrane, leading to disruption of neuronal transmission to the brain	Augmentation of potassium levels, lightheadedness, feeling faint, irregular heartbeat, respiratory depression, muscle stiffness, bluish skin, confusion, nail beds, shortness of breath, numbness slips, fingers, hyperthermia, stiffness in the jaw.	[19].

Drug's name	Therapeutic effect	Side effects	Reference
Etomidate	A unique drug used to induce general anesthesia and sedation. It was observed that in healthy subjects, low dosages of the medicine result in few changes to the heart rate (<10%).	Pain at the injection site, postoperative nausea or vomiting, skeletal muscle movements, and adrenocortical suppression.	[20].
Ketamine	Stimulators of all parts of the central nervous system directly or indirectly stimulate a characteristic pattern of augmented voltage, with slow frequency spike discharges alternated with low voltage and fast frequency desynchronized activity. Because of the potential for dose-dependent elevations in blood pressure, and cardiac output, ketamine should be administered with care to patients with cardiovascular problems.	Hallucinations, confusion, extreme fear, unusual thoughts, painful or increased urination, blood in urine, incontinence, bradycardia, lightheadedness, shallow breathing, blurred or double vision, lucidity, nausea, insomnia, loss of appetite, or vomiting, hypertension, tachycardia, arrhythmias.	[21].
Propofol	Intravenous anesthetic which may be safely used for the induction and maintenance of anesthesia throughout most surgical operations.	Breathing, lightheadedness, severe pain, bradycardia or tachycardia, shallow burning, stinging at the injection site, or a mild rash. Prolonged use – propofol infusion syndrome, which can result in death.	[22].
Midazolam	Oral anesthetic medication used for sedation, 5 times more potent than diazepam.	Blurred vision, nausea or vomiting, sweating, decreased ability to swallow (especially at higher doses), body aches, depressed airway reflexes and dizziness, chills, fever, congestion, sore throat, insomnia, irregular heartbeat, disorientation, blue or pale lips, fingernails.	[18].

ANESTHESIA IN CONGENITAL HEART DISEASE

Congenital heart disease (ChD) represents one of the most common birth defects. A study published in 2019 highlighted an overall incidence of ChD of approximately 10/1000 live births worldwide, with atrial septal defect, patent ductus arteriosus, and ventricular septal defect as the three most frequent anomalies [23].

A recent study including 78 cardiac surgical centers from Germany analyzed the congenital cardiac surgery program. Centers included were asked to participate in an online questionnaire to assess their current anesthetic practice. Results showed that 27 German centers had an active program for congenital heart surgery, ensuring more than 3,000 pediatric cardiac surgeries every year. Standard induction agents were etomidate in 26.9%, propofol in 19.2%, a combination of ketamine with benzodiazepines in 19.2%, and barbiturates in 11.5%. Sevoflurane was the most common volatile agent used to induce general anesthesia 81.2%. The intraoperative first-line inotropic medicine was epinephrine, 53.8%, followed by milrinone, 23.1%, and dobutamine 15.4%. Thus, this study showed the diversity of protocols applied in pediatric cardiac anesthesia for patients with ChD exposed to surgery in Germany [24].

OBSTETRIC ANESTHESIA AND HEART DISEASE

Cardiovascular disease is the leading cause of maternal mortality cause in the United States. Epidural catheters are frequently used during labor to reduce pain and can be placed via an epidural, dural puncture epidural, or combined spinal-epidural technique. When an epidural catheter is fixed, usually a test dose of epidural medication is followed to infirm/conform unintentional intrathecal or intravascular placement. A classic test dose consists of 3ml of lidocaine 1.5% or 2.0% with epinephrine 1:200,0000 dilution. In women with

cardiac disease, it is essential to ensure that the risks outweigh the benefits of a traditional test dose. This classic intravascular dose of epinephrine 15mcg in patients with a history of stenotic heart lesions, arrhythmias, or severe aortopathies could be dangerous. In these cases, fentanyl 50–100 mcg can be a more suitable intravascular test dose, the specialist has to ask the patients to report any effects of intravascular opioid administration [24]. In patients with cardiovascular disorders, the intrathecal test dose should also be carefully chosen because high spinal anesthesia has been observed after intrathecal test doses which would be badly tolerated in a woman with cardiovascular disease [25]. Here, lidocaine may be changed to 5ml aliquots of the epidural labor analgesia solution (e.g. 1-2mcg/mL fentanyl with bupivacaine 0.0625% - 0.125%) and assess the patient for intrathecal placement every 5 minutes until the anesthesia is established [26].

CONCLUSIONS

Cardiac pathology is a constantly evolving problem. Therapeutic approaches often require the involvement of both general and partial or local anesthesia, therefore it is essential to know the particularities of anesthetic drugs in the case of these subjects. In heart surgery, etomidate seems to be a good choice in terms of maintaining stable blood pressure and pulse rate. In congenital cardiac pathologies, standard induction agents are etomidate, propofol, and a combination of ketamine with benzodiazepines, and barbiturates. In obstetric cases, it is essential to analyze cardiac pathology and possibly replace standard medication with special drugs, adapted to the patient's needs.

Conflicts of Interest

The authors declare no conflict of interest.

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