

Effects of Surgical Anesthesia on Postoperative Cognitive Function of Elderly Patients

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Abstract: Postoperative cognitive dysfunction in elderly patients is a common complication after surgical anesthesia. The occurrence of complications is also related to many other factors, and the cause is still unclear. This paper reviews the influencing factors and corresponding measures for postoperative cognitive function of elderly patients caused by anesthesia.

Keywords: Surgical anesthesia; Elderly patients; Postoperative cognition

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1 Introduction

The symptoms of POCD range from mild memory loss to the inability to concentrate or process the information received by the brain, which severely affects the patient's quality of life. The main clinical symptoms are cognitive dysfunction, memory impairment, anxiety, personality changes and mental disorders. Although surgery is getting more advanced, the incidence of cognitive dysfunction after surgery has not decreased, which interferes with the normal life of patients and adversely affects the recovery from the disease. Moderate to severe dementia can manifest as memory impairment, decreased judgment,

language and personality changes. It is considered to be the early stage of Alzheimer's disease. When reaching the stage of mild cognitive dysfunction, treatment can reduce the risk of Alzheimer's disease^[1].

2 Overview of Postoperative Cognitive Function Decline

Under normal circumstances, patients will develop cognitive dysfunction within a few weeks after surgery, and it may persist in some patients for several months. Most people with mild POCD are able to carry out daily activities independently, but some patients develop severe dementia compared to before the operation, and the symptoms persist until death. This may be due to the combined effects of a variety of factors leading to an increase in the prevalence of POCD in elderly patients. These factors include physiological changes associated with aging, such as central nervous system degeneration, the body's ability to cope with stress, and surgery and anesthesia. These results may be related to the type and duration of anesthetics studied and the method of assessing cognitive function^[2].

POCD patients are mainly elderly patients underwent anesthesia surgery. The initial symptoms of POCD are not obvious, usually mild discomfort and mental disorders. Therefore, the early POCD did not catch the attention of patients and their families.

3 Possible Mechanisms of Anesthesia-induced POCD

The possible mechanism of POCD induced by anesthesia is the effects of anesthesia on cognitive functions. The exact mechanism is still unclear. Cognitive functions are more easily affected by the action of drugs. Since general anesthetics are highly fat-soluble, the general anesthetics entering the brain easily dissolved in the cell membrane, penetrate the organelles, and act on various receptors, ion channels, secondary messenger systems and cytoskeletal components. There are more and more studies on cells cultured *in vitro*, rodents and non-human primates, which indicates that general anesthetics may be neurotoxic to immature and aging brains. Postoperative cognitive decline has become a major health problem for the elderly. Studies have reported on the role of anesthetics in postoperative cognitive decline. The potential relationship between the type and dosage of anesthetics and the occurrence and progress of POCD has attracted more and more attention. However, the specific mechanisms between anesthesia and POCD are still unclear^[3]. Studies have shown that anesthetics are the main cause of POCD, including direct toxicity, dynamic changes in calcium ions, systemic inflammation, senescence inhibition of neural stem cell functions, and endogenous neurodegeneration promoted protease activation. Cell culture studies have shown that volatile anesthetics may induce cell death and increase the formation of amyloid.

In addition, as the amount of desflurane increases, amyloid-oligomerization also increases. Another study showed that isoflurane is a drug that promotes amyloid precursor degradation enzyme activity and amyloid precipitation. Tau protein is a microtubule-related protein that stabilizes axon microtubules, mainly in the brain and spinal cord. The phosphorylation of tau protein is related to neuronal cell death, and to a certain extent participates in the progress of neurodegenerative diseases. Researchers found that patients with impaired cognitive functions after surgery have higher tau protein levels^[4].

There is also a correlation between elevated serum tau protein level in patients with non-cardiac surgery and cerebral infarction. Since tau hyperphosphorylation is one of the neurophysiological indicators of Alzheimer's disease, it is speculated that

tau hyperphosphorylation may be the cause of POCD or Alzheimer's disease. Although anesthesia has a certain relationship with the change in tau protein, the phosphorylation of tau protein may be related to POCD, because it can inhibit the phosphatase activity and secondary tau hyperphosphorylation during anesthesia, but not the anesthesia itself. During tau hyperphosphorylation, the patient's body temperature can only be partially reduced. There are two possible explanations for this phenomenon. One is that tau phosphorylation caused by anesthesia is a key factor in POCD. Another problem is that if the body temperature is maintained at a normal level during anesthesia, the hyperphosphorylation of tau protein will be reversed, which will affect the brain nerves. It can serve as potential protection. Most studies have shown that many anesthetics can promote tau hyperphosphorylation at low temperatures.

4 Main Influencing Factors of Surgical Anesthesia-Induced POCD

4.1 Various Methods of Anesthesia

The research data of POCD at home and abroad and many clinical observations and analyses show that anesthesia is closely related to POCD. The incidence of cognitive dysfunction in elderly patients who underwent cardiac surgery is significantly different from those who received general anesthesia and local anesthesia. The incidence of postoperative cognitive dysfunction in locally anesthetized patients is significantly lower than that in patients who received general anesthesia. The cause is related to the degree of central nervous system damage and orthopedic diseases. As a result, the arterial pressure and heart rate of anesthetized epidural patients were significantly better than those who received general anesthesia, while the mental status score of the latter was significantly lower than that of anesthetized epidural patients, and the incidence of POCD in the anesthetized epidural group was significantly lower than that of the general anesthesia group.

4.2 Various Choices of Anesthetics

After surgery, different anesthetics will have different effects on patients with cognitive dysfunction. The use of appropriate anesthetics can effectively reduce the incidence of POCD patients and effectively reduce the severity of POCD. In addition, related

studies have shown that a reasonable reduction of the anesthetic dose can effectively reduce the damage of anesthetics to the central nervous system and reduce the severity of POCD. For example, studies have shown that dexamethasone can significantly reduce the probability of POCD after surgery. In elderly orthopedic patients under general anesthesia, ketamine combined with dexamethasone anesthesia and appropriately reducing the drug dose can significantly reduce the incidence of postoperative irritation and reduce the incidence of POCD in patients^[5].

4.3 Age

Age is the only widely accepted risk factor for the incidence and progress of POCD. Clinical studies have shown that the incidence of POCD is almost related to age. The brain of the elderly is more susceptible to changes mediated by anesthetics because the brain of the elderly is different from the brain of the young in terms of neurotransmitter types, metabolic function and plasticity. On the other hand, the adaptability of body continues to decline with age. Sudden illnesses and trauma usually require higher psychological and physical adaptability, which may lead to cognitive dysfunction.

4.4 Depth of Anesthesia

Excessive use of general anesthesia during surgery can seriously affect early postoperative cognitive function, aggravate postoperative cognitive dysfunction in elderly patients, or cause long-term cognitive decline. The toxicity and side-effects of general anesthesia on central nervous cells depend on the dose. Excessive use of general anesthesia per unit time will increase nerve cell damage and apoptosis^[6].

4.5 Elderly Patients have more Diseases

There are two types of general anesthesia: inhalation anesthesia and intravenous anesthesia. Sevoflurane is the most common inhalation anesthetic, and its mechanism of action is unclear. Sevoflurane has a fragrant smell and does not cause respiratory irritation. It can be used to induce anesthesia in newborns, children and elderly patients. It has less myocardial inhibition and can better maintain hemodynamic stability. It is not metabolized by the liver and kidneys, and its blood/gas partition coefficient is 0.63. The initial form is eliminated directly from the lungs, but it can be quickly restored

by increasing the respiratory rate and tidal volume. Propofol is the most common fast-acting intravenous anesthetic and its mechanism of actions on the central nervous system includes: inhibiting the release of excitatory neurotransmitters through the GABAA receptors acting on the postsynaptic membrane. Inhibit Na⁺ channel and reduce the release of glutamate; non-competitively inhibit K⁺-induced Ca²⁺ influx and reduce intracellular Ca²⁺ concentration. Propofol not only reduces brain metabolism, cerebral blood flow and intracranial pressure, but also inhibits peripheral circulatory resistance and myocardial contraction in a dose-dependent manner. The elderly have poor cardiac reserve, decreased sinus node function, left ventricular hypertrophy, decreased compliance, and decreased blood vessel wall thickness and elasticity. When the body volume is insufficient, the above factors lead to decrease in cardiac output, increase in pulse pressure difference and circulatory fluctuations. In addition, general anesthesia has different effects on the cardiovascular system.

5 Measures to Reduce the Incidence of Anesthesia-induced POCD in Elderly Patients

Cognitive dysfunction is more common in elderly patients within a few days after surgery, and there are many symptoms in the central nervous system, of which obvious changes in cognitive function are the main symptoms, such as memory loss, changes in calculation skill, and decreased ability in comprehension and concentrating. Elderly people usually show symptoms of cognitive dysfunction such as difficulty concentrating within 3 days after surgery, but some elderly patients still have symptoms of cognitive dysfunction within 7 days after surgery, especially at night. This paper proposes some measures.

5.1 Comfort and Preparation before Surgery

Before surgery, the patient's underlying disease should be improved as much as possible, and the risk factors that may cause cognitive dysfunction should be actively corrected. Provide psychological intervention for patients to eliminate anxiety and fear of surgery. During the surgery, choose the most suitable operation mode. Correct surgical procedures can reduce bleeding and other related phenomena, and prevent hemoglobin from falling off after surgery.

Select an anesthetic method and anesthetic that best suits the patients, and then choose an anesthetic that has little effect on the central nervous system. Meanwhile, pay close attention to the management of anesthesia and the depth of anesthesia during the operation to eliminate the patient's stress response.

5.2 Good Sleeping Environment

A good sleeping environment can improve the sleep safety and comfort of elderly patients. Due to blood shortage and imbalance between yin and yang, the elderly are more sensitive to external heat and cold, so adequate room temperature and humidity help with sleeping. The elderly patients with insomnia should be placed in a separate ward, the bed should be soft and comfortable to reduce adverse stimulation, and the lights should be turned off before going to bed.

5.3 Reasonable Medication for Patients with Insomnia

The medical staff should clarify with the patients that drug intervention is only an important means of restoring the patient's normal sleep. Meanwhile, in order to use drugs reasonably to make patients fall asleep, attention should be given to the time and dosage of the drugs. At the same time, closely monitor the patient's reaction to the drugs and immediately report any adverse reactions to the superior doctor.

6 Conclusion

POCD is common after surgery in elderly patients. A large number of studies have shown that general anesthesia can affect the memory and cognitive function of operated patients. Therefore, the anesthesiologist should deepen the understanding

of the disease, explain the condition patiently to the patient and family before the operation, reduce the patient's anxiety, reduce the psychological burden, adjust the patient's overall condition as much as possible, and keep the patient's organ functions at the best status.

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