GENERAL ANAESTHESIA IN PATIENTS WITH CEREBROVASCULAR DISEASES - RISKS AND COMPLICATIONS

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Summary: The aim of the study is to present the problems arising during general anesthesia in patients with cerebrovascular diseases, taking into account the appropriate perioperative preparation. When planning the anesthetic procedure strategies aimed at the prevention of cerebral ischemia or hemorrhage into the brain must be taken into account.
Material and research methods: a descriptive analysis was applied on the basis of the literature collected from the years 1992 to 2013.
Conclusions: Preoperative evaluation of patients with cerebrovascular disease requires a thorough neurological examination, assessment of cardiovascular complications, including the risk of cerebrovascular, respiratory, renal, and endocrine system complications. During general anesthesia one should take care of haemodynamic stability and proper ventilation parameters. The choice of anesthetic agents so that during the induction of anesthesia, throughout anesthesia, during the recovery from the anesthesia there is no risk of hemodynamic instability and an appropriate level of blood perfusion in the brain is maintained. In the postoperative period the neurological status of the patient should be assessed, in order to ensure that he does not demonstrate symptoms of delirium and that he does not experience a recurrence of previous neurological deficits. Each surgery and anesthesia should be discussed with the operator in terms of the risks and benefits of surgery. Scheduled surgery in patients with acute cerebrovascular incidents need to be postponed until their performance is reasonably safe for the patient.

Key words: general anesthesia, ischemic stroke, intracerebral hemorrhage, cerebral vascular malformation

Introduction

Cerebrovascular diseases are responsible for a large portion of complications resulting from neurological diseases. They more often lead to disability than death and they are associated with insufficient blood flow in part or all of the structures of the brain. Advances in the treatment of cerebrovascular significantly increase patient survival. More and more patients with a history of CVD require general anesthesia for operations other than neurological. It is in such cases that the additional requirements for anesthesia are required (Kohl, Rosenbaum, 2010). At all stages of perioperative care, the anesthesiologist must plan such action to prevent cerebral ischemia or hemorrhagic stroke, select the optimal anesthetic technique and an appropriate level of monitoring (Kohl, Rosenbaum, 2010).

Cerebrovascular diseases are usually divided into occlusions, such as narrowing of the carotid arteries and intracranial bleeding, as a result of which there is bleeding, such as endovascular aneurysm or arteriovenous malformation.

General anaesthesia in patients with occlusive cerebrovascular diseases

The brain is supplied with blood through the carotid arteries (providing approximately 80% of the total cerebral blood flow (CBF) and vertebral arteries (approximately 20% CBF), which extend from the extracranial section of the aorta and other large arteries, then run through the neck, the base of the skull into the cranial cavity

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(Rowland, Pedley 2012). In case of 5-10% of patients over the age of 65 more than 50-percent carotid stenosis is detected (O'Leary et al. 1992 Fine-Edelstain and in.1994). Most common risk factors for cerebrovascular occlusive diseases are: atherosclerosis, vascular congestion and hypertension. Occlusion of the common carotid and vertebral-basal are frequently encountered in the elderly group of the population.

Cerebral circulation in these patients is maintained by cerebral autoregulation, which allows maintaining blood flow in a wide range of perfusion pressures (50-150mm Hg), the collateral blood flow from the circle of Willis and other sources (Joshi et al. 2001). Autoregulation of cerebral circulation consists of reflex cerebral vasoconstriction in response to elevated average arterial blood pressure and expansion in case of its reduction. The driving force of cerebral blood flow (CBF) is a perfusion pressure (CPP), which is dependent on the mean arterial blood pressure (MABP) and intracranial pressure (ICP). The correct value of the CPP is 70mmHg (Zauner et al. 2002).

The intracranial pressure equates to from 7 to 15 cm H 2 O in the horizontal position is directly related to the pressure inside the thoracic and records changes in the respiratory system. When the intracranial susceptibility decreases slight increase in volume causes an increase in ICP, such changes may cause anesthetics like halothane, isoflurane, vasodilators, hypercapnia, and trauma or surgery.

Procedure related to anesthesia in patients with known cerebrovascular stenosis is primarily dependent on adequate cerebral perfusion pressure to prevent new or recurrent episodes of ischemia.

The preoperative evaluation should pay attention to the symptoms, duration, severity and etiology of previous ischemic events. Any acute or residual neurological change should be noted, that it can be applied to any symptoms that occurred in the postoperative period. The standard procedure should require postponing all elective surgery if an ischemic episode occurred during the last four weeks. Post-stroke changes, such as increased permeability of the blood-brain barrier, impaired autoregulation of cerebral blood flow, or loss of response to CO2 concentrations may persist for longer than 4 weeks (Finnigan et al. 2007, Zhao et al., 2009).

In the anesthesia examination it should be noted whether when changing the position of the head there is no reaction in the form of ischemia, on a clear airway and whether there is a presence of sleep apnea, both its central and obstructive form. A common perioperative complication in these patients is aspiration pneumonia and nosocomial pneumonia (Kohl, Rosenbaum, 2010).

In this group of patients, there is a large proportion of serious comorbidities on important systems and organs. They are often related to the cardiovascular system. The anesthetist should gather a detailed history, perform a physical examination of the designation of the output of blood pressure. It is recommended to perform the ECG to detect possible changes in ischemic myocardial infarction or arrhythmia. Additional examinations such as transthoracic echocardiography, transesophageal echocardiography are recommended if there is a need to perform an overall assessment of myocardial function, heart valves, barrier function or intracardiac thrombi possible detection and evaluation of the aorta (Aitkenhead et al., 2008).

Patients with cerebrovascular diseases often have dysphagia disease, gastroesophageal reflex, and other stomach diseases (Schaller et al. 2006). Should assess the nutritional status of the patient and consider the continuation of parenteral nutrition during surgery in patients chronically malnourished.

A common comorbid disease in these patients is diabetes. Glucose levels during anesthesia and in the postoperative period must be closely monitored and the insulin must be administered according to the protocol. Maintaining normoglycemia patronage indirectly influences the brain. Hyperglycemia is an indicator of poor prognosis in patients with focal cerebral ischemia (Weir et al. 1997). Hypoglycemia is also dangerous, which can be more damaging to the damaged brain tissue than hyperglycemia (Van den Berghe et al., 2009).

Preoperative preparation also requires the completion of a full panel of laboratory tests to assess the state of hydration and serum electrolytes. Electrolyte disturbances may be caused by a disease or may have an iatrogenic origin. One should also assess renal parameters, perform hematology and coagulation system check. Patients with a high risk of ischemic stroke apply preventive anticoagulation and antiplatelet (Kohl, Rosenbaum, 2010).

Patients for elective surgeries are most often diagnosed, but if the diagnosis has not been made, Doppler examination should be performed on carotid and vertebral arteries using angiography and magnetic resonance (MR). These studies may be helpful in determining perioperative actions. MRI is helpful in detecting the so-called „silent" ischemic lesions of the brain in patients with transient ischemic attack (TIA), which is particularly important when it is expected that a high-risk or cardiac surgery will be performed (Latchaw et al., 2009).

When selecting anesthetic agents to provide anesthesia one should take into account their impact on cerebral blood flow, particularly in patients with hypertension who are permanently taking pressure lowering drugs, because the use of anesthetics may increase ischemic brain perfused distal areas to the place of stenosis of cerebral vessels. One should consider the merits of lowering medication, or raising the blood pressure on the basis of baseline blood pressure, type of thrombolytic therapy and the patient's overall condition. Higher risk of cerebral edema and hemorrhage occurs in patients with hypertension (Kohl, Rosenbaum, 2010).

At each stage of anesthesia in patients with cerebrovascular disease the anesthesiologist must maintain proper cerebral perfusion pressure, cerebral blood flow to prevent the decline in cerebral blood flow and embolism. These activities are aimed at protecting brain tissue. Intravenous anesthetics, with the exception of ketamine, depending on a dose cause as CNS depressants on metabolism, reducing the oxygen demand of the brain, reducing CBF by secondary cerebral vasoconstriction, reducing ICP. Benzodiazepines are often used for premedication of patients before anesthesia, because they act anxiolyticly, sedatively, and antiepilepticly inducing lack of memory. Undoubtedly, this has a beneficial effect on the porotection of brain tissue because it removes the blood pressure increases induced by anxiety of patients before surgery.

Benzodiazepines also reduce the demand of the brain tissue for oxygen, reducing cerebral blood flow without loosing the vascular response to changes in carbon dioxide concentration. These measures should be used with caution, however, especially in patients with cerebrovascular disease, because the side effects of benzodiazepines include drowsiness and impaired psychomotor skills, as well as reducing ventilation and retention of carbon dioxide (Aitkenhead et al. , 2008).

Another group of drugs used during anesthesia is opioids. They have a minor and transient effect on intracranial pressure and on cerebral perfusion pressure. They cause a slight decrease in cerebral blood flow and cerebral oxygen consumption. For premedication they should be used with caution, because particularly in case of the elderly persons, they can cause respiratory depression and retention of carbon dioxide. (Aitkenhead et al. , 2008).

Nondepolarizing agents blocking neuromuscular conduction used for general anesthesia have little effect on the function of the CNS. In contrast, depolarizing muscle relaxant succinylcholine causes an increase in intracranial pressure, and therefore it should be used with caution in patients with elevated ICP or it may be best to choose a non-depolarising agent (Mayzner-Zawadzka, 2009).

Among the inhaled anesthetic agents most commonly used in general anesthesia there are isoflurane, sevoflurane and desflurane, which in concentrations exceeding 1.5 MAC have similar effects on intracranial homeostasis. Sevoflurane has an influence on biochemical processes at the cellular level and it has neuroprotective properties visible in its ability to modulate perfusion as a result of reactions which limit the extent of damage. It has the protective effects of focal cerebral ischemia (Duffy, Mata, 2000). Isoflurane has similar properties to sevoflurane.

Both the induction of anesthesia, intubation, and procedure of waking-up should be done with caution, taking into account the difficulties in maintaining patient's airway, the risk of aspiration and airway obstruction. Sudden fluctuations in blood pressure need to be avoided, and patients need to be extubated after the wake up from anesthesia.

Monitoring of patients with cerebrovascular diseases during general anaesthesia

Monitoring of patients and adequate intravenous access should be tailored to the type of surgery. For each patient, a standard monitor includes: a non-invasive monitoring of blood pressure, heart rate, oximetry pulse, monitoring of ventilation parameters, and temperature. If an arterial line is set up this allows for continuous invasive blood pressure monitoring, as well as facilitates blood samples for research. It is important to maintain blood pressure within „normotension" to stabilize the cerebral perfusion pressure, and protect brain tissue against further ischemia (Jellish 2006). During the surgery, one should also monitor arterial blood gases, serum electrolytes and glucose in the blood.

Postopertive period

Each patient in the postoperative period should have an assessment of the neurological status carried out, and attention must be paid to possible symptoms of delirium or on recurrence of previous neurological deficits. Pain should be monitored and fought against, because it directly stimulates the sympathetic nervous system which leads to the release of catecholamines and an increase in blood pressure. During this period we monitor the respiratory and circulatory systems (Kohl, Rosenbaum, 2010).

In patients with a history or existing brain hemorrhages

This intracerebral haemorrhage is an acute spontaneous blood extravasation into the brain, which can spread to the chambers, less frequently into the subarachnoid space. Subarachnoid hemorrhage due to aneurysms account for 5-15% of strokes and are subject to high mortality. Within a month of illness about 30-40% of patients die, and approximately 50% of patients die within six months from the occurrence of brain hemorrhage. The most

common and the most important factor is the risk of intracerebral hemorrhage hypertension, which badly treated damages blood vessels causing fragmentation, degeneration and rupture of an artery in the brain parenchyma piercing (Rowland, Pedley 2012).

Another risk factor is alcohol abuse, which interferes with platelet function, and may trigger vascular fragility. The use of antiplatelet drugs also increases the risk of spontaneous bleeding into the brain tissue in patients with hypertension. Risk factors that do not undergo modification include age, smoking, and male gender (Rowland, Pedley 2012).

Preoperative preparation of patients with cerebrovascular aneurysms or intracerebral bleeding requires a thorough evaluation by an anesthesiologist of aneurysm rupture risk factors, to determine the duration of the disease since its diagnosis and aneurysm growth and changes in morphology. Comorbidities, particularly regarding cardiovascular and breathing should be taken into account. Preoperative blood pressure assessment and its treatment is essential. Antihypertensive therapy must be optimized, as during anesthesia and the surgery itself sudden pressure surges threatening aneurysm rupture may occur (Kohl, Rosenbaum, 2010).

Intraoperative Procedure: during general anesthesia it is necessary to maintain cerebral perfusion pressure at the appropriate level and to minimize the transmural pressure in the aneurysm. Haemodynamic stability should be maintained during the induction of anesthesia and the intubation. Fluctuations in blood pressure within 20% of baseline are considered as acceptable. The introduction of anesthesia should be mild, generally used with additional anesthetic intracranial pressure-lowering mechanism of the reduction of cerebral blood flow. During the operation too light level of anesthesia ought to be avoided. However, during the waking up time after the anesthesia hypercapnia, hypoxia and airway obstruction should be avoided, since these factors contribute to the development of cerebral edema (Larsen 2003).

In a post-operative procedure an increase in blood pressure above 20% must not be allowed. If necessary antihypertensive drugs should be applied. If possible, neurological assessment of patients should be performed in order to rule out neurological deficits that would indicate the occurrence of intracranial complications.

A special group of patients is formed by patients with venous malformations arteriovenous (AVM). These malformations are more common among younger people and are a major cause of neurological diseases and mortality associated with hemorrhage. Cerebral arteriovenous malformations, are present at a frequency of 10-18 cases per 100,000 adults (Stapf et al. 2003). Anesthetic perioperative procedure towards patients with non-fractured AVM is similar to that in cases of aneurysms. It is necessary to maintain a stable blood pressure, and after waking from general anesthesia it is necessary to conduct neurological examination (Kohl, Rosenbaum, 2010).

Purpose of study

The aim of the study is to present the problems that occur during general anesthesia in patients with cerebrovascular diseases, taking into account the appropriate perioperative preparation.

Material and methods

Descriptive analysis of the literature from the years 1992 to 2013 was applied. Cases of patients with severe cerebrovascular disease were analyzed, taking into account the preparation for surgery under general anesthesia and the problems and risks associated with general anesthesia and the perioperative period.

Discussion

In clinical practice, due to the progress in the treatment of acute cerebrovascular incidents anesthesia is increasingly applied to patients undergoing non-neurological surgeries who had ischemic or hemorrhagic stroke. This creates additional requirements for anesthesia. Anesthetic procedure is targeted at prevention of cerebral ischemia or cerebral hemorrhage. The preoperative examination should take into account comorbidities, medications taken by the patient and, finally, the state of the cerebral circulation (Kohl, Rosenbaum, 2010).

Patients with cerebral ischemic strokes often take oral anticoagulants (McGrath et al. 2013). There is a risk of increased bleeding during surgery. These patients should be adequately tested from anesthetic point of view before any scheduled surgery to change the antithrombotic prophylaxis into a safer heparin.

Despite the adequate preparation of patients with known vascular disease of the brain during anesthesia and in the postoperative period vascular events of acute character may occur. If the patient during anesthesia suddenly undergoes a bradycardie and high blood pressure, it is usually associated with the occurrence of hemorrhage com-

bined with a sudden increase in intracranial pressure (Young 2007). Acute ischemic attacks and minor vascular cracks in patients who are under general anesthesia may take place generally in the form of difficulty in waking up from anesthesia, disturbances of consciousness and focal neurological deficits. In case of ischemic changes in the brain thrombolytics medications are applied to improve peripheral perfusion (Berkowitz et al. 2013)

In the case of acute intracerebral hemorrhage, blood pressure should be maintained at a lower level of the norm, and if anticoagulant therapy was applied, it should be immediately neutralized. If we are dealing with an increase in intracranial pressure during intracerebral haemorrhage, the patient should be treated with the method of ICP-lowering including the following actions such as: the supply of mannitol, elevation of the head by 15 degrees, normocapnia, normothermia or cooling during fever. Every patient with suspected embolism or ruptured aneurysm requires a computed tomography in an urgent mode (Kohl, Rosenbaum, 2010).

Rupture of an aneurysm is an event that has catastrophic consequences. Thanks to the greater availability and better research techniques many cases of asymptomatic intracranial aneurysms are diagnosed during routine radiological examinations. In the case of high-risk aneurysms intravascular or operational clipping is made preventing its rupture (Ishibashi et al. , 2009).

Rare disease, which the anesthetist may encounter, is the Moyamoya disease. It is an occlusive cerebrovascular disease manifested through ischemia or cerebral hemorrhage. This disease may be accompanied by intracranial aneurysms (Vercauteren, Heytens 2007). The treatment is conducted through the application of vasodilators, anticoagulant and antiplatelet drugs as well as surgery. The prognosis is however bad.

General anesthesia in patients with cerebrovascular diseases shall be applied in such a way, so as to ensure above all the haemodynamic stability. The critical moment is the introduction of anesthesia and intubation, especially in case of intracranial aneurysm surgery. The frequency of rupture during the induction of anesthesia is approximately 1%, but it is subject to 50% mortality. Therefore, it is recommended that the use of large doses of opioids, thiopental, etomidate or propofol and in addition the supply of ß-blocker, or a blocker αß lignocaine (Levy, Nowicki 2002). One can apply the inhalatory methods and the technique of total intravenous anesthesia (TIVA), or combine these two techniques (Kohl, Rosenbaum, 2010).

Cerebrovascular diseases lead to failure of vital organs and systems, which should be taken into account during anesthesia and within the perioperative period. When it comes to subarachnoid haemorrhage ischemic stress of the hypothalamus occurs and leads to a massive burst of catecholamines. The consequence of this mechanism is in systemic disorders of the cardio-respiratory and water-electrolyte balance. For almost 100% of patients changes in the ECG in the form of bradycardia, tachycardia, atrioventricular dissociation, and sometimes ventricular tachycardia or ventricular fibrillation are observed. These disturbances occur within the first 48 hours after subarachnoid hemorrhage and may persist for up to several weeks (Lam 2001).

Increase in the concentration of catecholamines in patients with severe neurological condition can lead to neurogenic pulmonary edema. Disorders of consciousness, respiratory depression, decreased reflexes of the throat and larynx increase the risk for aspiration pneumonia. Meanwhile, the most frequently observed electrolyte disturbances in the course of SAH include hyponatremia, hypokalemia and hypocalcemia (Levy, Nowicki, 2002).

Conclusions

1. Preoperative assessment of patients with cerebrovascular diseases requires careful neurologic examination, evaluation of cardiovascular complications, including the risk of cerebrovascular, respiratory, kidney and the endocrine system complications.

2. General anesthesia must be performed in such a way so as to maintain hemodynamic stability, which ensures an adequate cerebral blood flow.

3. In the postoperative period it is necessary to implement the treatment of pain-relief, since pain leads to increased intracranial pressure, impaired ventilation, adversely affecting the cardiovascular system.

4. Each procedure and anesthesia should be discussed with patient's surgeon or neurosurgeon, depending on the type of operation in order to determine whether the benefits of surgery outweigh the risks associated with it.

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