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Mini Review

Anesthesia for epilepsy surgery

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Introduction

Anesthesia for neurosurgery, "neuro-anesthesia", involves techniques, drugs, monitoring and objectives as diverse as the area of surgical activity is vast (surgery for vascular alterations, tumors, craniostenosis, spine, epilepsy, etc.). The present chapter will address the anesthetic treatment of patients undergoing epilepsy surgery, a treatment that, in addition to having points in common with those practiced in other neuroaesthetics subspecialties, presents, perhaps, the most critical particularities for the anesthesiologist. The drug interactions between antiepileptic drugs and anesthetics, the influences of anesthetics on electroencephalography, and the need to keep the patient, with the brain exposed, under very superficial levels of general anesthesia, or even to make such a patient wake up, calm and cooperative, during the procedure, are major concerns and real challenges.

Depending on the type of surgery and the proposed neurophysiological procedures, one can opt for general anesthesia, pure local anesthesia, or what is conventionally called "conscious sedation" associated with local or locoregional anesthesia. This last technique, in particular, has made great advances in recent years thanks to the emergence and clinical application of new drugs and monitoring methods. The most commonly used anesthetic drugs and a brief comment regarding their effects on the electroencephalogram follow.

Anesthetic drugs

Inhalation agents: These drugs, as a group, cause EEG activation at low doses and suppression as these doses are increased. Isoflurane is today, perhaps, the most used inhalational agent in our midst and despite the possible suppression of epileptic activity on electrocorticography (ECoG) many services use it in low concentrations (£ 0.3 MAC -minimum alveolar concentration-) together with opioids, uninterruptedly, without problems.

Fast low-voltage electroencephalographic activity at low concentrations, bursts of B activity at 1 MAC, burst-suppression at 1.5 MAC, and isoelectric EEG with levels greater than 2 MAC are observed [1,2]. Desflurane and Sevoflurane are more expensive alternatives that, at the low doses commonly used in these cases, probably do not have clinical advantages that justify their high cost. Halothane would not initially be a drug of choice for neurosurgical procedures because of its detrimental effects on cerebral blood volume and delay in anesthetic reversal. Enflurane is associated with the appearance of seizures, mainly in conjunction with severe hypocarbia [3]. Furthermore, it may be related to the appearance of spikes in normal areas during ECoG. Nitrous oxide causes changes in the EEG when used in concentrations greater than 25%, causing rapid activity of low amplitude and slowing of the EEG in low and high doses, respectively [4]. Nitrous oxide has been related to the potentiation of the proconvulsant effects of other drugs [5] and the suppression of spike activity on EcoG, leading some services to not use it in epilepsy surgery.

Intravenous drugs

Short-acting barbiturates such as thiopental, methohexital, and amobarbital are used in anesthesia and have a dose-dependent effect on the EEG, again with small doses causing the onset of rapid B activity, and larger doses leading to the onset of delta activity, burst-suppression and silence electric [6,7]. Both thiopental and methohexital have a proconvulsant action at low doses, becoming anticonvulsants at higher doses. Due to their long-lasting anticonvulsant action, the use of benzodiazepines should be avoided when ECoG is part of the procedure. Etomidate is an ultra-short-acting hypnotic agent with an electroencephalographic profile similar to that of barbiturates. In epileptic patients, it induces the appearance of interictal spikes and can cause clinical epileptic seizures [8] and can be used as an inducer of epileptic activity during diagnostic ECoG. At higher doses, it has anticonvulsant activity. Droperidol used in the neuroleptoanalgesia technique has an intense antiemetic action even at low doses (0.01 mg/kg). It is associated with a lowered threshold for seizures. Propofol, probably the drug most used today as a hypnotic in neuroanesthesia, is also the subject of controversy regarding its pro- and anticonvulsant potential [9,10]. At low doses, it promotes an increase in the frequencies a which gives rise to a fast B rhythm and q as the dosages increase [11]. It is also related to the emergence of abnormal movement. Controversies aside, it is considered the safest agent for sedation in resections of epileptic foci [12]. Neuromuscular blockers do not affect the EEG, except atracurium, whose main metabolite, laudanosine, when taken in large amounts seems to have an excitatory effect on the EEG [13]. Non-depolarizing relaxants have their action time reduced in users of antiepileptic drugs, while succinylcholine seems to have its effect prolonged by these drugs. Resistance to neuromuscular blockers is increased when steroids are associated with antiepileptic drugs. Local anesthetics also have a biphasic behavior, having an anticonvulsant effect at low doses and a convulsive effect at higher doses. They should be used for blocking the scalp in relatively low concentrations (0.25% - 0.5%) and always added with vasoconstrictors.

A detailed analysis of electrophysiology and the effects of anesthetic drugs on it is far beyond the scope of this chapter, and the above serves to reinforce the notion that this field of study is extremely complex and often controversial. For the conduct of anesthesia, from a practical point of view, more important than the detailed knowledge of the effects of each drug on the electroencephalogram, is the awareness of the existence of these effects and the need to use those drugs that have less chance of compromising the intraoperative neurological approach and in the lowest possible doses, whenever the safety of the anesthetic act allows it.

On the other hand, anesthetic drugs undergo drug interactions with antiepileptic agents such as carbamazepine, fezine and phenobarbital, which lead to increased metabolism of steroids, opioids and a certain degree of resistance to non-depolarizing neuromuscular relaxants, in addition to interactions and side effects not directly related to anesthetics.

Anesthetic management

Epilepsy surgery can be performed under general or local anesthesia with sedation, (or even a pure local technique), according to a prior decision on the need for localization of the epileptogenic area and particular needs for intraoperative neurological monitoring.

General anesthesia

In cases of well-defined epileptogenic foci far from eloquent areas, in which it is not necessary to carry out EcoG and mapping of the motor area, "classic" general anesthesia can be used, as we can name it, with the use of sedation, hypnosis, conventional analgesia, and muscle relaxation, with choice of drugs according to the practices of each service. If electrophysiological studies are scheduled, some particularities in anesthetic management become mandatory.

Due to the risk of influencing the ECoG, the use of pre-anesthetic sedative medication is avoided and induction is performed with short-term hypnotics such as propofol, thiopental, or etomidate. Likewise, fast metabolism muscle relaxants such as atracurium, vecuronium, rocuronium, etc. are used, if stimulation of the motor area is foreseen. As for opioids, the most used in these cases is sufentanil and alfentanil, both in continuous infusion and in divided doses.

Monitoring, induction and positioning

With the patient in the operating room already with peripheral venous access, initial monitoring with an electrocardiogram, pulse oximetry, and non-invasive blood pressure measurement are installed. After measuring these parameters, induction is performed with the appropriate drugs for each case, orotracheal intubation, the start of controlled ventilation, palpebral occlusion, and installation of the rest of the monitoring, which consists of capnography, analysis of expired gases, large-caliber venous access (if the initial considered insufficient) arterial access for constant invasive blood pressure measurement and delayed urinary catheterization. The patient is then positioned properly for surgical access and additional care is completed, such as positioning the limbs and padding the bony eminences.

Maintenance

Ventilation is regulated according to capnography in order to maintain normocarbia. Maintenance of anesthesia is achieved with an inhalational agent (for example, isoflurane or sevoflurane), with or without the addition of nitrous oxide and opioids. In our service, we preferably use a continuous infusion of relatively low doses of sufentanil or alfentanil, which are increased during electrophysiological studies. Muscle relaxants can also be infused intermittently or continuously, in which case they should be stopped early enough. A recovery greater than 90% of muscle strength measured by TOF is necessary in order not to impair the observation of the motor response to cortical stimulation.

During electrophysiological studies, in addition to the maintenance of opioids, isoflurane (£ 0.5 CAM) can be used with or without nitrous oxide (£ 25%) without affecting the results. When programming is only motor area stimulation, a deeper level of anesthesia is allowed, mainly with the use of intravenous drugs. After the end of this phase, the use of muscle relaxants and deepening of anesthesia using the technique of choice can be resumed.

When it comes to general anesthesia for epilepsy surgery two dominant ideas stand out. One refers to the great controversy regarding the effects of anesthetic agents on the results of electrophysiological studies and the very validity of these studies.

The other is well characterized by Trop D, et al. "The absence of muscle paralysis...combined with a very light level of anesthesia to avoid interference with the ECoG represents an inadequate state of anesthesia" [14].

The anesthesiologist in charge of this type of procedure must give due importance to these facts, as he is responsible for the care and safety of the patient about the maintenance of his vital functions and physical integrity. In particular, during the pre-anesthetic evaluation, the possibility of the patient eventually waking up during the procedure and under very adverse conditions (presence of the orotracheal tube, eyelid occlusion, skull fixation, etc.) should be emphasized. An event of this type, in addition to the momentary difficulties and risks for the anesthesiologist and the patient, can cause intense emotional problems [15] and may even lead to lawsuits. For this reason, the situation and the risks involved in these procedures must be exhaustively discussed during the pre-anesthetic evaluation and the anesthesiologist must be sure of the patient's understanding and acceptance.

Local anesthesia

Depending on the proposed electrophysiological studies, such as, for example, speech area mapping, local anesthesia is chosen. The emergence of new anesthetic drugs, anesthesia administration techniques, and monitors has allowed safer and more efficient sedation for these patients. Although the neuroleptoanalgesia technique, with the use of droperidol and fentanyl [16], or the use of propofol and opioids in a continuous infusion regimen on an mg/kg/hour basis, can present good results, the emergence and popularization of target-controlled infusion of anesthetic drugs, with the determination of the desired concentration at the site of action, has been promoting a renewal in the specialty. In our environment, the most used technique in this type of anesthesia is the target-controlled infusion of propofol followed by continuous infusion of opioids, usually sufentanil or alfentanil.

Monitoring, induction and positioning

Initial monitoring and taking the first measurements is the same as for general anesthesia, and the patient must also already have venous access. A nasal cannula is installed to measure the CO, expired and mainly, to monitor the respiratory rate, and an initial dose of 10 mg/kg to 20 mg/kg of alfentanil is injected followed by a continuous infusion of 0.5 mg/kg to 1.0 mg/kg/min. Then, propofol infusion is started at a target concentration titrated by the patient's response to stimuli such as urinary catheterization, arterial access, injection of local anesthetic and surgical incision. Concentrations between 1.5 mg/kg and 3.5 mg/ml are generally adequate.

The local anesthetic used in our service is generally bupivacaine at a concentration of 0.25% to 0.5% plus adrenaline 1 200,000. The blocking technique usually employed is the anesthesia of the supratrochlear and supraorbital, auriculotemporal, posterior auricular branches, and greater and lesser occipital nerves. Additionally, an anesthetic is injected along the incision line [17,18]. It may be necessary to inject the anesthetic into the dura mater on both sides of the middle meningeal artery to ensure analgesia of this structure and the blood vessels during the surgery. Scalp anesthesia also has the hemostatic function of the surgical wound.

For definitive positioning, airway patency must be optimized by neck extension and constantly reassessed during surgery. Instruments such as an oropharyngeal airway and laryngeal mask airway may be necessary and should always be easily accessible. The limbs are correctly positioned, the bony eminences are padded and the patient is covered with a thermal blanket. It is essential to maintain a direct line of sight between the patient's face and the anesthesiologist so that he/she can exercise constant vigilance.

Maintenance

During the procedure, an insufficient level of analgesia, as demonstrated by hypertension and tachycardia, can be controlled by increasing infusion rates or bolus doses of intravenous drugs, or by additional injection of local anesthetic. When deepening the anesthetic level, it is necessary to pay attention to the respiratory rate to avoid exaggerated depression of ventilation and compromising the anesthetic-surgical procedure. A high flow of oxygen directed to the patient's face should be maintained to optimize FIO. Usually, after a few minutes of interruption of the propofol infusion, the patient regains consciousness, usually in a confused and agitated manner. At that moment, the presence of the anesthesiologist at your side, reassuring verbal contact, and delicate physical restraint are essential for the success of the procedure.

The anesthetic management of these patients, controlling the anesthetic depth and predicting awakening, is greatly facilitated by the use of Bispectral Index (BIS) monitoring, when available. The use of remifentanil [19], an opioid with an ultra-short duration of action, whose half-life is not affected by the duration of the infusion, is probably the best option, but this is a little widespread drug among us because of its high cost. Another promising technique is the use of dexmedetomidine in continuous infusion. It is an α_2 -agonist with a specificity ratio between α_2 and α_1, about 10 times greater than clonidine, which has important hypnotic and analgesic properties with little respiratory depression [20,21].

In the pre-anesthetic evaluation of these patients, gaining confidence is extremely important for a good result from anesthesia. Ideally, contact with the patient should take place on two occasions so that all doubts generated by the very explanation of the procedure can be formulated and resolved. Of paramount importance is the knowledge of several details of the patient's state of health, such as preferred sleeping position, orthopedic problems that make it impossible to establish certain positions, claustrophobia, severe cough of any etiology, behavioral changes, nasal obstruction, etc., among others, which may alert to the increased chance of failure due to the simple impossibility of the patient cooperating with the procedure. The patient must be fully aware of the course of the surgery and the importance of his cooperation.

Conclusion

This work demonstrated a broad vision of the anesthetic treatment of patients submitted to epilepsy surgery with the use of pre-anesthetics and pre-operative clinical details relating to surgical procedures, a treatment that, in addition to points in common with those practiced in other neuroaesthetics subspecialties presented the most critical particularities for the anesthesiologist.

Anesthesia for neurosurgery, "neuroanesthesia", involves techniques, drugs, monitoring, and objectives as diverse as the surgical area is vast (surgery for vascular alterations, tumors, craniostenosis, spine, epilepsy, etc.). The influences of anesthetics on electroencephalography, and the need to keep the patient, with the brain exposed, under very superficial levels of general anesthesia, or even to make such a patient wake up, calm and cooperative, during the procedure, are major concerns and real challenges.

The risks involved in these procedures must be taken into account during surgical planning and thoroughly discussed during the pre-anesthetic evaluation, and the anesthesiologist must be sure that the patient understands and accepts them. The patient must be fully aware of the course of the surgery and the importance of his cooperation.

Therefore, the anesthesiologist must assess the risks of each case and his ability, due to the weight of his responsibilities, to act in the face of possible adversities, always aiming at the greater good, which is the physical integrity of the patient under his care. The watchwords in conducting these cases are integration and harmony, which summarize what the working environment should be between neurosurgeons, neurologists, and anesthesiologists. Understanding and respecting the priorities and prerogatives of each team member will determine an increase in the number of good results and reduce the rate of complications to the minimum possible.

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