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Case Report

Dexmedetomidine Administration does not Affect Electrocorticography Reading during Epilepsy Focal Removal Surgery

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Abstract

Epilepsy prevalent across all ages and genders, making it one of the most widespread neurologic disorder. Worldwide, 20-40% of epilepsy patients are refractory or resistant to oral anti-epileptic drugs, requiring surgery to treat their seizures. The use of electrocorticography (ECoG) can help determine the focus of epilepsy and requires anaesthetic drugs that do not affect the electroencephalography (EEG) readings during surgery. The aim of this case was to study the effect of using dexmedetomidine (DEX) as additional to maintenance anesthesia in epileptic craniotomy surgery with ECoG. A 28-year-old man came to the hospital with complaints of recurrent seizures, generalized tonic-clonic type seizures that lasted 2-3 minutes, was unconscious during the seizure, fell asleep afterwards, and recurred 2-3 times a day. The patient had suffered from epilepsy since 4 years ago. Physical and supporting examinations were within normal limits. Head MSCT examination with contrast suspected oligodendroglioma. The patient was administered dexmetomidine while underwent epilepsy craniotomy surgery with ECoG to remove the tumor which was suspected to be the epileptic focus. The choice of anesthetic agent in epilepsy craniotomy, especially when involving ECoG modalities, requires special consideration to improve intraoperative quality and postoperative outcomes. Propofol is the most widely used induction agent. However, these agents have anticonvulsant effects and activate non-specific spike waves in large areas of the brain. This has the potential to interfere with spike wave monitoring with ECoG. The use of dexmedetomidine has been shown to produce a stable hemodynamic effect and does not affect the ECoG readings. The use of DEX as an adjuvant in anesthesia maintenance does not inhibit spike waves during surgery, so ECoG can be used effectively for anesthesia in craniotomy operations with ECoG.

Keywords: Convulsions, craniotomy; dexmedetomidine, electrocorticography, epilepsy

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I. Introduction

Epilepsy is a disorder of the brain characterized by a persistent predisposition to produce epileptic seizures.[1] Epilepsy is one of the most common neurological diseases and affects all ages, genders and races in the world. The prevalence of epilepsy is not yet known with certainty, but a meta-analysis shows the incidence rate of epilepsy is 61.4 per 100,000 people per year.[2] Low-grade Epilepsy-associated Neuroepithelial Tumors (LEAT), is a type of brain tumor that is associated with seizures, have similar clinical characteristics, such as onset of seizures at a young age, a tendency to involve the temporal lobe, and are benign, including a slow growth pattern but a long-term history of seizures. Gangliogliomas and dysembryoplastic neuroepithelial tumors are characteristic of LEAT.[3] Epilepsy management is complex and requires tailored approaches for each patient.[4]

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Medically refractory epilepsy refers to persistent seizure activity despite treatment with two or more antiepileptic drugs. According to a recent meta-analysis and systematic review, it's prevalence in Latin America was estimated at 14,09 per 1000 population, with an incidence of 1,11 per 1000 person-years.[5] The case fatality rate was 1.04 per 100,000 population according to a report from PanAmerican Health Organization.[6] Twenty to forty percent of epilepsy patients are refractory or resistant to oral anti-epileptic drugs, requiring surgery to treat their seizures.[7] Craniotomy surgery for epilepsy is a therapeutic modality that continues to develop. Craniotomy for epilepsy aims to resect or ablate a number of epileptogenic tissues to eliminate seizures, as well as minimize the amount of disturbed tissue to maintain the important functions of the patient's brain.[8]

Intraoperative electrocorticography (ECoG) is extensively used to pinpoint the epileptogenic focus, guiding resection, and evaluating the surgical outcome.[9] It is also necessary to pay attention to the use of anesthetic agents in these operations, so that they have a minimal depressant effect on the electrical activity of the brain.[10] Long-term consumption of anti-epileptic drugs is associated with resistance to neuromuscular blocking agents, so anesthesiologist should consider advising patient to temporarily stop consuming regular medications, especially if ECoG is used. Opioid anesthetic such as fentanyl and remifentanil have no effect on background ECoG, while propofol have been found to activate or suppress spikes with dose-dependent effect. Compared to other anesthetic, the usage of dexmedetomidine (DEX) has gain more interest, since it has shown a promising result in the field of neuroanesthesia.[11] We report a case using DEX anesthesia for maintenance in a patient undergoing epilepsy craniotomy surgery with ECoG.

II. Case

Anamnesis/Disease History

A 28 years old man came to the hospital with complaints of recurrent seizures since 5 days prior. Anamnesis revealed that the patient experienced generalized tonic-clonic type seizures that lasted 2–3 minutes, was unconscious during the seizure, fell asleep afterwards, and recurred 2–3 times a day. The patient had his last seizure 2 days before admission to the hospital with the same semilogy lasting about 5 minutes. When he came to the hospital, the patient was not having seizures, was fully conscious but tended to be slow to respond. The patient previously had a history of intermittent headaches for the past 5 years, as well as a history of first seizures 4 years prior. After being examined and given medicine by the doctor, the patient abandoned prescribed treatment and chose herbal treatment.

Physical Examination

Physical examination of the patient showed that he was fully conscious, vital signs showed blood pressure 110/62 mmHg, pulse 82 x/minute, breathing 18 x/minute, temperature 36.6 C. Neurological examination of the cranial nerves, motor function and peripheral sensory were within normal limits.

Supporting Examinations

Multi-slice Computerized Tomography (MSCT) examination of the head with contrast on November 14th 2023 showed a solid mass with minimal calcification with vasogenic edema

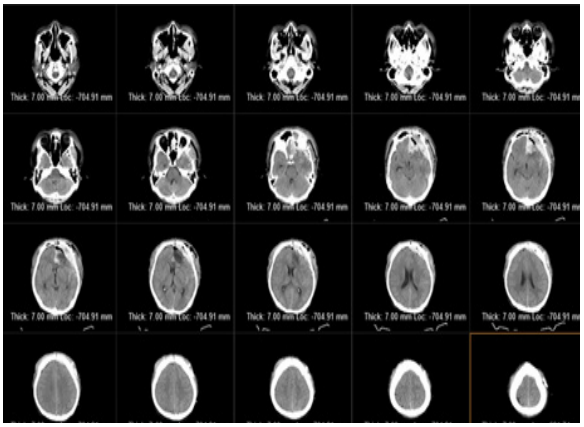


Figure 1. Magnetic Resonance Imaging (MRI) Examination of the Head Spectroscopically, there was an intra-axial solid inhomogeneous mass with a necrotic area inside and surrounding vasogenic edema in the gray-white matter of the left frontal lobe (size 2.4 x 2.2 x 2.5 cm)

in the gray-white matter of the left frontal lobe and suspected oligodendroglioma. Magnetic Resonance Imaging (MRI) examination of the spectroscopic head on November 15 2023 showed an image of an intra-axial inhomogeneous solid mass with a necrotic area in it at the same location (Figure 1). Spectroscopy showed an increase in the intralesional and perilesional Choline/N-Acetyl Aspartate ratio, which supports the picture of high grade glioma. On a chest x-ray examination on November 13 2023, no abnormalities were found.

The patient was diagnosed with intracranial SOL suspected a primary tumor, low-grade epilepsy-associated neuroepithelial tumors (LEAT), and epilepsy. During preoperative treatment, the patient did not experience seizures and received injection therapy of dexamethasone 10 mg/12 hours, phenytoin 200 mg/24 hours, vitamin B12, omeprazole, paracetamol, folic acid, sucralfate, and levetiracetam 500 mg/24 hours. Preoperative laboratory examination showed no abnormalities. The patient underwent a long-term EEG examination to confirm the epileptic zone, and the administration of phenytoin and levetiracetam was postponed during the examination. The patient was scheduled for epilepsy craniotomy surgery with electrocorticography.

Management of Anesthesia

The patient was positioned supine, induction using propofol 150 mg intravenously, fentanyl

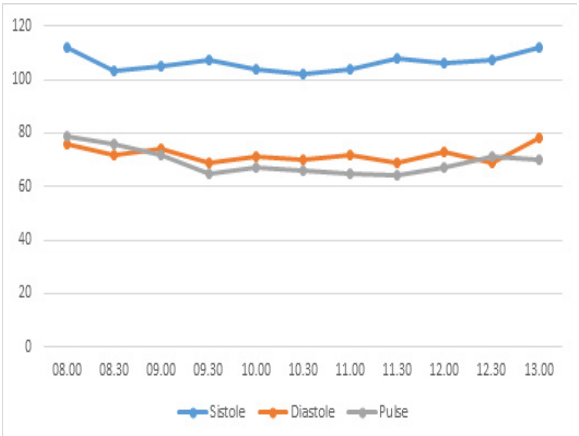


Figure 2. Graphic of Blood Pressure and Pulse during Surgery

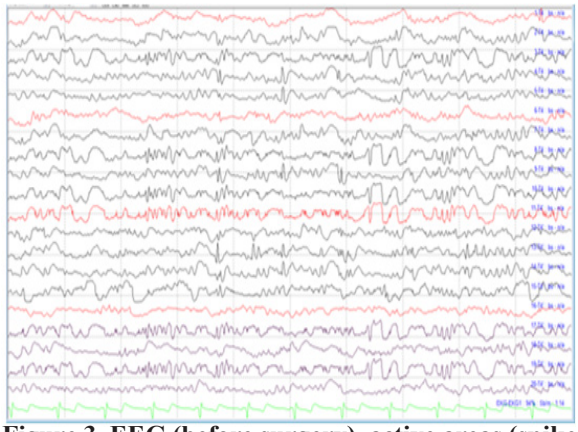


Figure 3. EEG (before surgery), active areas (spike waves) were obtained at points 7, 13, 14, and 15

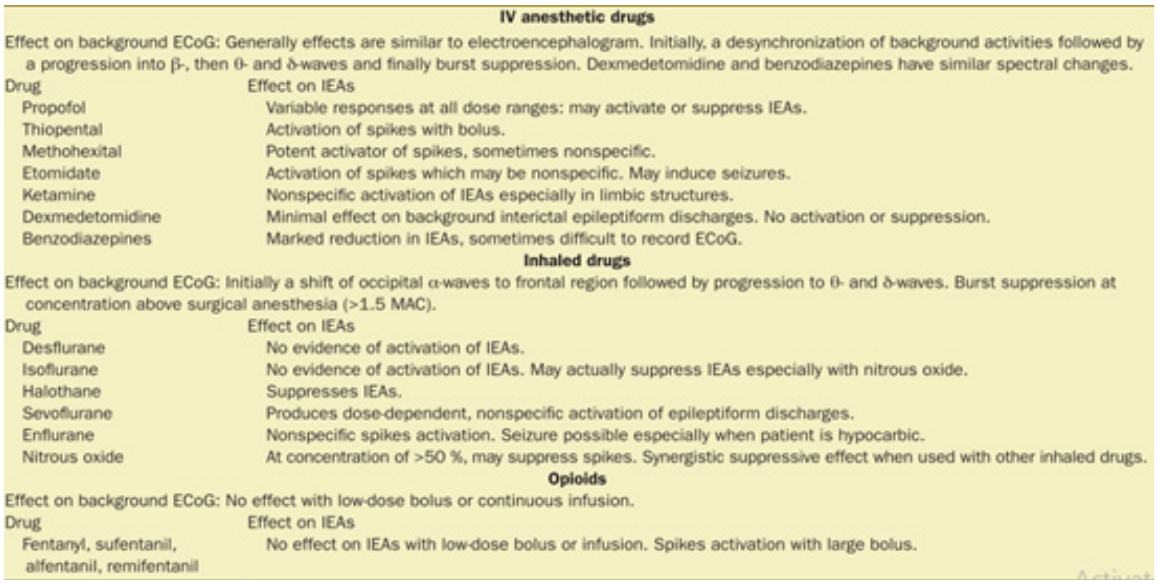
100 mcg intravenously, and rocuronium 40 mg intravenously. After the endotracheal tube number 7.5 was installed, the patient was given initial dose of dexmetomidine at 1 mcg/kgbb/minute for 10 minutes, followed by maintenance at a dose of 0.3–0.4 mcg/kgbw/minute. During surgery the inhalation agent used 1% sevoflurane in oxygen and air. During the operation there were not many hemodynamic disturbances (Figure 2), ECoG readings did not find any problems. Intraoperative bleeding was 500 ml, urine production was 2100 ml, fluids given were Ringer lactate 1000 ml, NaCl 0.9% 1000 ml, PRC 275 ml. The duration of surgery was 300 minutes, with duration of anesthesia was 360 minutes.

Post-Surgical Management

After surgery, the patient was extubated and continued treatment in the treatment ward, the patient appeared conscious and could communicate well. The patient was given paracetamol 1000 mg/8 hours orally, fentanyl 20 mcg/hour using a syringe pump, and ondancentron 4 mg/8 hours. During the postoperative period the patient's condition remained stable, hematology examination showed good results, and mobilization was initiated. After surgery, laboratory examination results showed that hemoglobin was 10.2g/dL with leukocytes 9,600ul.

III. Discussion

Epileptic seizures are conceptually defined as



IV anesthetic drugs	
Effect on background ECoG: Generally effects are similar to electroencephalogram. Initially, a desynchronization of background activities followed by a progression into β-, then θ- and δ-waves and finally burst suppression. Dexmedetomidine and benzodiazepines have similar spectral changes.	
Drug	Effect on IEAs
Propofol	Variable responses at all dose ranges: may activate or suppress IEAs.
Thiopental	Activation of spikes with bolus.
Methohexital	Potent activator of spikes, sometimes nonspecific.
Etomidate	Activation of spikes which may be nonspecific. May induce seizures.
Ketamine	Nonspecific activation of IEAs especially in limbic structures.
Dexmedetomidine	Minimal effect on background interictal epileptiform discharges. No activation or suppression.
Benzodiazepines	Marked reduction in IEAs, sometimes difficult to record ECoG.
Inhaled drugs	
Effect on background ECoG: Initially a shift of occipital α-waves to frontal region followed by progression to θ- and δ-waves. Burst suppression at concentration above surgical anesthesia (>1.5 MAC).	
Drug	Effect on IEAs
Desflurane	No evidence of activation of IEAs.
Isoflurane	No evidence of activation of IEAs. May actually suppress IEAs especially with nitrous oxide.
Halothane	Suppresses IEAs.
Sevoflurane	Produces dose-dependent, nonspecific activation of epileptiform discharges.
Enflurane	Nonspecific spikes activation. Seizure possible especially when patient is hypocarbic.
Nitrous oxide	At concentration of >50 %, may suppress spikes. Synergistic suppressive effect when used with other inhaled drugs.
Opioids	
Effect on background ECoG: No effect with low-dose bolus or continuous infusion.	
Drug	Effect on IEAs
Fentanyl, sufentanil, alfentanil, remifentanil	No effect on IEAs with low-dose bolus or infusion. Spikes activation with large bolus.

Figure 4. Effect of Anesthetic Drugs on Background Electrocorticography (ECoG) and Spontaneous Interictal Epileptic form Activities (IEAs).[9]

transient occurrences of signs and/or symptoms resulting from excessive or synchronous abnormal neural activity in the brain.[12] The selection of anesthetic agents in epilepsy craniotomy, especially when involving the ECoG modality, requires special consideration to improve the quality of intraoperative and postoperative outcomes (Figure 4). Clinicians are encouraged to utilize anesthetic agents that have minimal or no effect on electrical activity in epileptogenic areas of the brain (figure 3). Propofol is the most widely used induction agent. However, these agents have anticonvulsant effects and activate non-specific spike waves in large areas of the brain. This has the potential to interfere with spike wave monitoring with ECoG so that propofol is used only for induction.[13] Inhaled agents such as isoflurane and desflurane, at concentrations >1.5 MAC, have been found to eliminate interictal epileptiform discharge.[14]

Opioid agents aim to selectively heightened neuron excitability, aiding in the identification of epileptogenic foci within the brain. However, the triggered of the spike waves that are too high for the size of the epileptic zone when mapping is a weakness of this agent.[15] The effects resulting from the use of these drugs, especially when used in combination with inhalation agents and opioids, have been shown to affect the ECoG recording process and have the potential to impact on intraoperative decision making. Dexmedetomidine has been found to have a satisfactory pharmacokinetic and pharmacodynamic profile. Dexmedetomidine acts on presynaptic α-2 receptors, so its effects are non-cortical and subcortical. DEX showed minimal to no effect on interictal spike activity. When administered in combination, DEX reduces the necessary dosage of other anesthehic agents duting both induction and maintenance, consequently enhancing the depth of anesthesia and therby improving the quality of ECoG recordings.[7] DEX infusion at a dose of 0.5–0.7 ug/kg /hour does not affect ECoG, making DEX a better alternative to propofol because it is able to maintain sedation, stable hemodynamics, and analgesia with minimal interruption of ECoG.[7]

Another consideration in the use of DEX is its effect on the intraoperative hemodynamic profile, which is important for good postoperative outcomes. The use of DEX has been shown to produce clinically stable hemodynamic effects and does not produce side effects in epilepsy craniotomy with ECoG.[16] Short-duration DEX

administration in patients with drug-resistant temporal lobe epilepsy and demonstrated transient and long-range hemodynamic changes very short. However, another study on DEX administration for a longer duration showed a bradycardic trend, with a decrease in blood pressure that was still variable.[17] Dexmedetomidine have also been shown to causes intraoperative seizures more frequently in awake craniotomy than propofol, but still considered a valid alternative as it does not put the patient in a statistically significant greater risk for intraoperative seizures onset.[18] This indicates the need for close monitoring during the ECoG process in epilepsy craniotomy.

IV. Conclusion

The interaction of anesthetic drugs and their effect on intraoperative ECoG needs to be a primary consideration in craniotomy surgery in patients with epileptic focus in the motor area. The use of DEX does not have a significant effect on the ECoG results so that the surgical area is more precise, and can result in better patient recovery.

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