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Case Report

Opioid-Free Anesthesia Technique in Craniotomy Arteriovenous Malformation (AVM) Resection (Anesthetic Management)

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ABSTRACT

Intracranial arteriovenous malformation (AVM) is a rare cerebrovascular abnormality that may cause bleeding, seizures, or neurological deficits. Treatment options, including surgery, embolization, and radiosurgery, are based on lesion size, location, and symptoms. In neurosurgery, Enhanced Recovery After Surgery (ERAS) aims to reduce pain, accelerate recovery, and shorten hospitalization. Opioid-Free Anesthesia (OFA), as part of ERAS, minimizes opioid-related complications and supports faster postoperative recovery. A 43-year-old woman presented with seizures and decreased consciousness. Angiography revealed an AVM in the right lateral parietooccipital region, classified as Spetzler Martin Supplementary Grade VI. She underwent craniotomy and AVM resection under OFA. Induction included dexmedetomidine loading at 0.7 mcg/kg for 10 minutes, followed by 0.2–0.5 mcg/kg/h maintenance. Anesthesia was maintained with target-controlled infusion (TCI) propofol in Schnider mode, effect-site concentration 3–5 mcg/mL. Lidocaine 90 mg and rocuronium 30 mg were also administered. Postoperative analgesia consisted of paracetamol 500 mg every 6 hours, ibuprofen, and dexmedetomidine infusion 0.2 mcg/kg/h. Multimodal anesthesia using dexmedetomidine, propofol, rocuronium, and lidocaine effectively replaced opioids, maintaining stable hemodynamics and adequate anesthesia. The combination of propofol and dexmedetomidine provided sedation, hypnosis, and analgesia, facilitating early extubation. The patient experienced rapid recovery without postoperative nausea or vomiting. AVM resection in a 43-year-old woman was successfully performed under OFA, with stable intraoperative conditions and no postoperative complications or neurological deficits. This case demonstrates the feasibility and effectiveness of OFA in complex neurosurgical procedures, supporting its broader application in clinical anesthesia practice.

Introduction

Intracranial arteriovenous malformation (AVM) is a rare vascular abnormality where arteries and veins connect directly, bypassing the capillary network. This condition can lead to impaired blood flow in the brain, increasing the risk of bleeding, seizures, and neurological damage. Despite AVM being discovered in asymptomatic patients, in some cases, it can develop into a life-threatening complication. The prevalence is approximately 1 in 100,000 people, with hemorrhage as the leading cause of stroke among younger individuals. Treatment options, such as surgery, embolization, and

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radiation therapy, depend on lesion size, location, and symptoms [1-3]. The concept of Enhanced Recovery After Surgery (ERAS) in neurosurgery is being developed to minimize pain and improve postoperative healing in patients, thereby reducing the length of hospital stay. Opioid-Free Anesthesia (OFA), an ERAS protocol for rapid recovery after surgery, has shown promising results in mitigating opioid-related complications. It is important to acknowledge that pain management strategies increasingly emphasize non-opioid agents [4-5].

In this case, a report of a patient with a Spetzler Martin-supplemented grade 6 AVM who underwent AVM resection craniotomy surgery with an anesthetic technique using OFA was presented.

Case Report

A 43-year-old woman arrived at the hospital with seizures and decreased consciousness. The patient had experienced severe headaches for 6 months and was previously subjected to digital subtraction angiography (DSA) and embolization. A planned surgery was organized, and a physical examination showed a GCS of E4MxVaphasia. Vital signs included blood pressure, pulse, respiratory rate, and temperature of 110/67 mmHg, 90 beats per minute, 13 per minute, and 36.0°C, respectively. Laboratory examination obtained Hb 9.2, Ht 28.8, Leu 7,190, Tc 177,000, GDS 76, PT/APTT/INR 16.4/33.0/1.20, Na 137, K 4.0, Cl 100, Ca ion 4.68, Mg 1.8. A non-contrast head CT scan showed compressed sulcus and gyrus, ventricle and cisterna compression, a hypodense lesion on frontoparietal dextra, and a hyperdense lesion suggestive of an artifact on parietooccipital dextra, with a midline shift (+) of less than 5 mm to the left. Contrast-enhanced head MRI presented a mixed-intensity lesion on parietooccipital dextra that was highly inhomogeneous with contrast administration. MR angiography identified an arterial-venous malformation measuring 4.7x4.1x4.3 cm, with a feeder originating from the right middle cerebral artery (MCA) and drainage to the superior sagittal sinus and Sylvian vein The radiological findings are shown in (Figure 1).

Figure 1- Results of supporting examinations

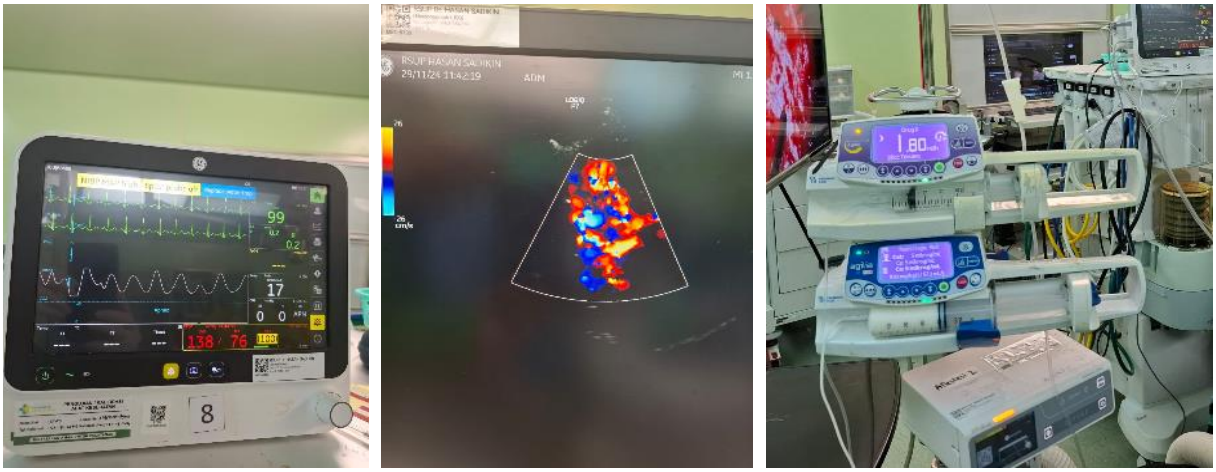

Figure 2- Preoperative hemodynamics, preoperative transcranial Doppler (TCD), maintenance TCI propofol and dexmedetomidine

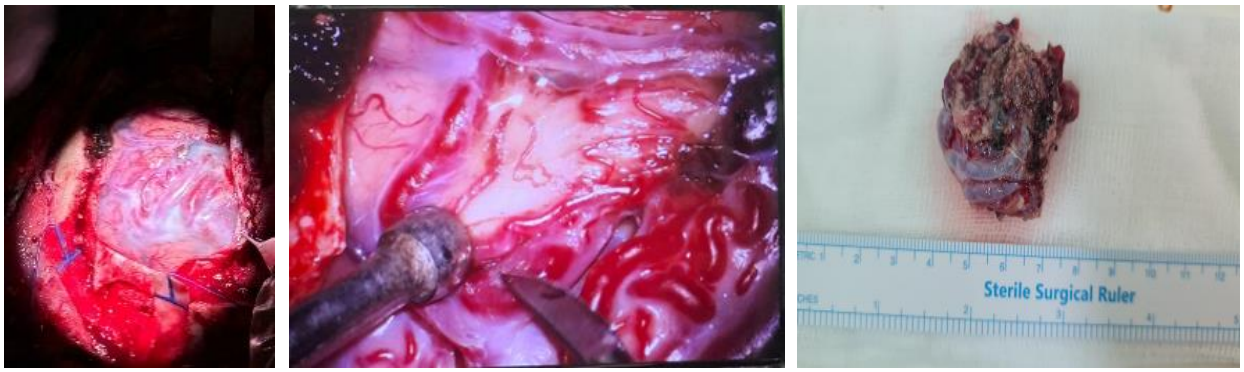

Figure 3- View of AVM after the dura was opened and after resection

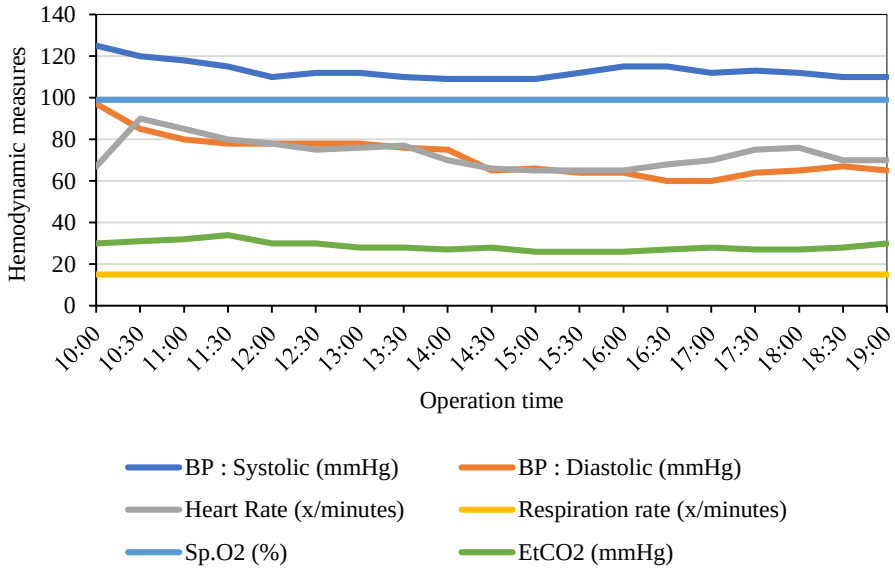

Figure 4- Hemodynamic features during surgery

The DSA result confirmed an AVM nidus of size 32x22x21 mm with a feeder from the right MCA and venous drainage to the superior sagittal sinus and Sylvian vein, after which embolization was performed.

The diagnosis was lateral parietooccipital AVM, Spetzler-Martin supplementary grading grade VI. Preoperative haemodynamic parameters and TCD findings are presented in (Figure 2). Anesthesia followed an opioid-free method with a dexmedetomidine loading dose of 0.7 mcg/kg for 10 minutes, maintained at 0.2 mcg/kg/hour, alongside 80 mg of lidocaine, target-controlled infusion (TCI) of propofol using the Schnider mode at a target effect of 4 mcg/mL, and 30 mg of rocuronium. During the operation, TCI propofol in Schnider mode with a target effect of 3-5 mcg/mL, O_2 and airbar, and mannitol 1 g/kgBB were administered. The intraoperative appearance of the AVM before and after resection is shown in (Figure 3). The operation lasted 10 hours, with relatively stable hemodynamics. Intraoperative haemodynamic trends throughout the procedure are illustrated in (Figure 4). After completion, early extubation was performed, and the patient was transferred to the High Care Unit. Postoperative analgesics included paracetamol 3x1000, ibuprofen 3x400, and a dexmedetomidine syringe pump at 0.2 mcg/kgBB/hour. On the first day after surgery, the patient's pain score was 3/10 on the Numeric Rating Scale (NRS).

Discussion

Brain AVM is a rare vascular lesion with an incidence rate of 1 case in every 100,000 population per year. However, the detection of unruptured and asymptomatic brain AVM is increasing with the development of more sophisticated radiological tools. Clinical manifestations

include mass effect, which can be caused by hemorrhage due to rupture of AVM nidus. Seizures and headaches are the most common symptoms. Brain AVM commonly occurs at a young age, with management strategies varying according to Spetzler-Martin's grading. Additionally, the risk of rupture is influenced by the characteristics of the lesion, such as size, age, location of the nidus, and history of rupture [6].

The study presented a case of a 43-year-old woman who had a headache, seizure, and loss of consciousness. The supplementary Spetzler–Martin grading used to assess the AVM severity in this case is presented in (Table 1).

Table 1- Supplementary Spetzler-Martin AVM grading scale

SM Grading	Points	Supplementary Grading
Size		Age
Small <3 cm	1	<20
Medium 3-6 cm	2	20-40
Large >6 cm	3	>40
Venous Drainage		Bleeding
Superficial only	0	Yes
Deep component	1	No
Eloquence		Compactness
No	0	Yes
Yes	1	No
Total	5	
SM-Supp point = 10		

In line with the literature, patients with AVM often present complaints of headache, seizures, hydrocephalus, and intracranial hemorrhage, which can cause neurological disorders and a high mortality rate. The symptoms commonly appear at the age of 20-45 years with a peak in the fourth decade, but cases can still be discovered at older ages [7-8]. Seizures occur in approximately 20-25% of intracranial AVM cases, either as focal or generalized [9]. The patient was subjected to DSA and embolization therapy, but the persistence of severe headache persisted. Based on observation, a decrease in consciousness was experienced until the seizure. AVM management options include conservative therapy, AVM resection, endovascular embolization, and stereotactic radiosurgery. The choice of therapy is guided by Spetzler-Martin Supplementary Grading. In this case, Grade VI classification was assigned to size 3-6 cm, age 43 years, without bleeding.

Optimal anesthetic management in patients subjected to brain AVM resection surgery requires an understanding of the goals of neuroanesthesia, such as maintaining stable hemodynamics in the procedure. This includes ensuring adequate cerebral perfusion pressure, preventing intracranial pressure increases, and anticipating serious perioperative complications such as intracranial hemorrhage [10].

The anesthesia technique in this case followed the OFA method, designed to support faster recovery and shorten treatment duration. Recently, the concept of Enhanced Recovery After Surgery (ERAS) in neurosurgery has been developed to reduce the length of hospital stay. OFA, a rapid recovery protocol after surgery, has shown promising results in reducing opioid-related complications [11].

The anesthesia applied includes a multimodal technique using specific agents to achieve the desired effect. Induction was performed by administering a dexmedetomidine bolus of 0.7 mcg/kgBB for 10 minutes, maintained at a dose of 0.2-0.5 mcg/kgBB, followed by propofol TCI using Schnider mode with a target effect of 3-5 mcg/mL, rocuronium 30 mg, and lidocaine. The combination of propofol and dexmedetomidine provided adequate maintenance of anesthesia and served as a substitute for opioids in terms of analgesia during surgery [12-13]. Additionally, preoperative analgesia included paracetamol 1 gram and ibuprofen 400 mg, which inhibited COX-3 as well as COX-1 and COX-2, respectively.

Dexmedetomidine is an alpha-2 agonist that has hypnotic, sedative, and analgesic effects. Studies with dexmedetomidine have shown a reduction in postoperative opioid use by approximately 60%. Dexmedetomidine presents analgesic effects without significant respiratory depression, provides good perioperative hemodynamic stability, and decreases intraoperative opioid requirements [13], while lidocaine has analgesic and anti-inflammatory effects. Several randomized controlled trials and systematic reviews have shown that perioperative intravenous lidocaine significantly reduces the need for opioids and the incidence of postoperative nausea and vomiting and improves the quality of recovery [12,14].

Following through surgery, early extubation is performed in the operating room. This was conducted in

consideration of the brain being relaxed during surgery, controlled bleeding, and stable hemodynamics. After extubation, the patient was admitted to the High Care Unit with blood pressure 110/70 mmHg, pulse 70x/min, and SpO2 99% with nasal cannula.

Exploring multimodal analgesia techniques can further optimize pain management in neurosurgery. ERAS is considered highly beneficial in speeding up recovery time as well as reducing hospitalization duration and treatment costs. However, perioperative pain management in craniotomy is a challenge for anesthesiologists, specifically with the development of the ERAS concept in neurosurgery, including AVM resection craniotomy.

Conclusion

In conclusion, cases of the disease were relatively rare, but anesthesia management in AVM resection craniotomy remained essential knowledge for anesthesiologists. The primary focus was to prevent secondary ischemia of brain tissue by maintaining stable hemodynamics, ensuring brain perfusion pressure remained close to normal, minimizing brain swelling, and anticipating bleeding. While the use of OFA was still not widely adopted in AVM surgery cases, the effectiveness in maintaining hemodynamic stability during surgery and after the procedure supported the concept of ERAS.

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