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Case Report

Neuroanesthesia Management in Cavernous Sinus Meningioma Craniotomy Patients

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Abstract

The most prevalent primary cavernous sinus (CS) lesion is cavernous sinus meningioma (CSM). Of all intracranial neoplasms, 1% are tumors in CS, and 41% are CSM. For contemporary neurosurgeons, orbital involvement in cavernous sinus meningiomas (CSMs) poses special difficulties. The condition is known as cavernous sinus meningioma (CSM) gradually impairs vision and may ultimately result in chiastic compression. Since January 2023, a male 55-year-old had been admitted to the hospital with cephalgia and mild diplopia in his right eye. Cavernous meningiomas were discovered using CT scans, and a craniotomy procedure was scheduled to remove the tumor. In order to facilitate intubation, the patient was given a premedication of sufentanyl for analgesia and was then given general anesthesia. Rocuronium was used to relax the muscles. Desflurane is an attractive option available to anesthesiologists to maintain general anaesthesia. This surgical procedure of removing intracranial tumours requires proper induction and monitoring of the patient's condition during surgery to prevent increased intracranial pressure. Intracranial elevation can cause systemic changes such as hypertension and changes in heart rhythm, as well as cerebral artery spasm, and lead to cerebral infarction and cerebral ischemia. An effective neuroanesthesia management program can help preserve hemodynamic stability and improve results during craniotomy surgery for the removal of meningiomas.

Keywords: cavernous sinus meningioma, orbital involvement, anaesthesia management

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I. Introduction

The most frequent primary cavernous sinus (CS) lesion is cavernous sinus meningioma (CSM). Of all intracranial neoplasms, 1% are tumors in CS, and 41% are CSM. For contemporary neurosurgeons, orbital involvement in cavernous sinus meningiomas (CSMs) poses special difficulties. Progressive ophthalmoplegia is the result of cavernous sinus meningioma (CSM), which might ultimately results in chiastic compression. Because cavernous sinus meningioma (CSM) is malignant, it presents a challenge to neurosurgeons worldwide. Fortunately, complete excision of the tumor is likely to result in ideal surgical outcomes. The location, degree of anaplasia, and source of meningioma neoplasms are used to classify them. According to WHO guidelines, meningiomas are generally classified into three groups: Meningiomas classified as benign (WHO Grade I), atypical (WHO Grade II), and malignant (anaplastic) (WHO Grade III). Prognosis and management approaches are impacted by each of these variables. In the US, 35,000 new cases of tumors are detected annually, with primary brain tumors accounting for 85% of these occurrences. Of all supra-tentorial tumors, 55–60% are primary brain tumors. Meningiomas (15%), pituitary adenomas (8%), and neuroepithelial tumors (35%), were the three types of primary brain tumors. Meningiomas occur at a rate of 7.8 per 100,000 people annually, however only 2.5 percent of them show symptoms.1 Neurosurgery is an operation with a long operating time, so the drugs used for maintenance

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during anaesthesia are essential. Cerebrospinal fluid, blood, and brain tissue make up the intracranial component. Monroe Kellie's law states that although the intracranial volume is constant, the volume composition of these three components can be varied, resulting in a constant overall volume. As a result, as the volume of one component increases, the volume of another component will decrease. One aspect of good neuroanesthesia is the prevention of intracranial component problems. Though it can reduce vascular resistance, particularly cerebral vascular resistance, the inhalation anesthesia technique has gained widespread acceptance in neurosurgical management. This can lead to an increase in intracranial pressure (ICP) and cerebral blood flow (CBF). When ICP is elevated, inhalation anesthesia procedures raise ICP, which lowers CPP and raises the risk of cerebral ischemia, which can cause brain injury.[2]

II. Case

Patient History

The patient complained of headaches six months earlier. Headaches were felt to disappear, and complaints aggravated when the patient was active, accompanied by right orbital pain and blurred vision. Allergies and other systemic diseases history were denied. History of diabetes mellitus, CVA, and hypertension were denied.

Physical Examination

We discovered during the physical examination that the patient's overall state seemed to be in moderate pain with awareness of GCS E4V5M6. On vital sign examination, blood pressure 145/85 mmHg, pulse 72x/minute, regular, solid contents and pressure, respiratory rate 18x/minute, SpO2 99% with room air, body temperature 36.8°C. anthropometric examination shows BMI (Body Mass Index) of 24.6 kg/m2. On examination of the head, the impression of mesocephalic, no anaemic conjunctiva or icteric sclera was obtained; on examination of cavum oris found, the presence of missing teeth and Malampati 2, no mass or enlarged lymph nodes in the neck were obtained. On thoracic examination, there was no lagging movement or retraction, and the lung and heart were within normal limits. Examination of the abdomen and extremities within normal limits. The patient was then carried out supporting examinations in the form of laboratory examinations, ECG, chest radiograph and Contrast brain CT scan. Brain CT scan showed an iso-slightly haemorrhage iso-slightly hyperdens extraaxial supratentorial lesion with a broad base in the right sphenoid with homogenous substantial contrast enhancement obliterating the right posterior optic canal, infiltrating the right optic nerve intaocular, musculus rectus media et inferior right can be a picture of meningiomas; There was no sign of increased intracranial pressure.

The patient entered the operating room with pre-induced compliments consciousness, blood pressure 122/69 mmHg, pulse 72x/min, respiratory rate 18x/min, body temperature 36.8 °C, and SpO_2 100% with desflurane gas 4%. Patients were under general anaesthesia using ETT non-kinking no. 7.5 semi-closed breathing control system, ondansetron premedication 4 mg intravenous (IV), dexamethasone 5 mg IV, preemptive analgesia sufentanyl 15 mcg IV, thiopental induction 250 mg, rocuronium 50

Preoperative Examination

Table 1. Results of laboratory tests

Laboratory	Result	Normal Values
Haemoglobin	13,5 g/dl	10.9 – 14.9
Hematokrit	40.9 %	34 – 45
Leukosit	9110/mm3	4790 – 11340
Platelets	262000/µL	216000 – 451000
Ureum	23.00 mg/dl	15 – 40
Creatinine	1.36 mg/dl	0.0 – 0.9
Albumine	Not checked	3.97 – 4.94
PT	11.9 seconds	11.7 – 15.1
APTT	30.9 seconds	28.6 – 42.2
SGOT	11.2 U/L	<31
SGPT	23.8 U/L	<31
GDS	115 mg/dl	80 – 139
Natrium	140 mmol/L	135 – 146
Kalium	5.0 mmol/L	3.6 – 5.2
Chlorida	108 mmol/L	97 – 108
Calcium	9.22 mg/dl	8.6 – 10.3
Hbsag	Non-reactive	Non-reactive

mg, FGF 3 L / min, maintenance ratio of O_2 60% and water 40%, VT 400 ml, RR 15x/min, MV 6000 ml, rocuronium 20 mg/hour syringe pump, sufentanyl two mcg/hour syringe pump.

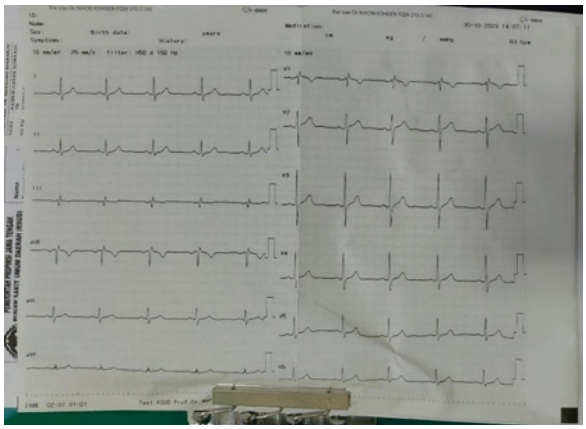

Figure 1. ECG Examination

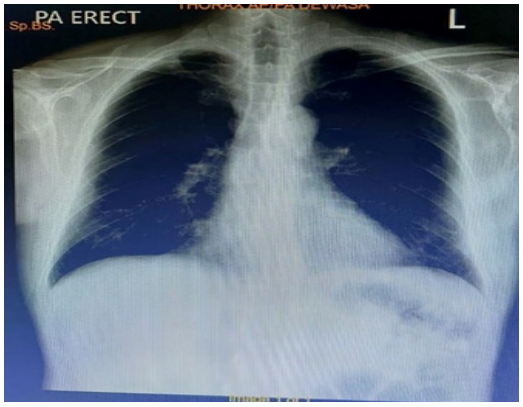

Figure 2. Chest Radiography

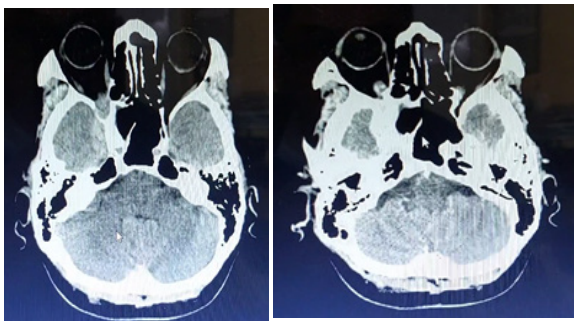

Figure 3. CT Examination Scan of the Head with contrast.

Head CT scan results showed iso-slightly haemorrhage iso-slightly hyperdense extra-axial supratentorial lesion with broad base in right sphenoid with homogenous contrast enhancement obliterating right posterior optic canal, infiltrating right optic nerve pars intraocular, right rectus media et inferior muscle suggestive of meningioma; No signs of increased intracranial pressure.

During surgery
The following is a hemodynamic chart of patients during surgery:

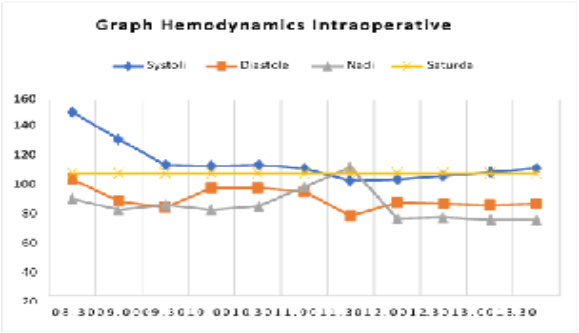

Figure 4. Intraoperative Hemodynamic Monitoring Chart

The patient was given tranexamic acid 1000 mg intravenously and vitamin K 10 mg. The fluids given during surgery are mannitol 20% 150 cc, Ringer Lactate 1000 ml, and NaCl 0.9% 700 cc. Bleeding during surgery, which is 200 ml. Urine output 800 ml, in clear yellow colour. The following is a picture of the excised meningioma mass:

Figure 5. Meningioma Masses

Post Operation
a. Treatment in the ICU
hemodynamics during treatment in the ICU were stable. Duration of treatment in ICU: 2 days (November 1, 2023 – November 2, 2023). The patient entered the ICU on November 1, 2023, at 13.00 WIB. The patient would be discharged from the ICU on November 2, 2023, at 12.00 WIB. Postoperative hemodynamics during ICU treatment:

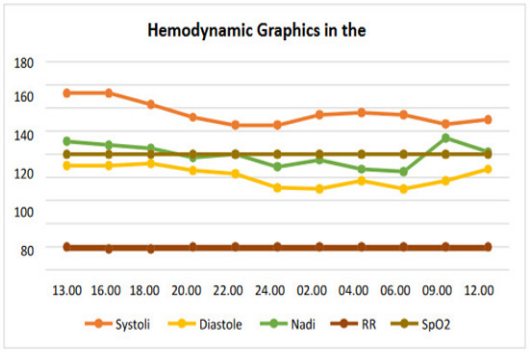

Figure 6. Monitoring Graph of Care in the ICU

The following are postoperative laboratory results during treatment in the ICU:

Table 2. Laboratory Results while in the ICU

Laboratory	1-11-2023	Normal Values
Haemoglobin	11.2 g/dl	10.9 – 14.9
Hematocrit	33.9 %	34 – 45
Leukosit	8830/mm3	4790 – 11340
Platelets	151000/µL	216000 – 451000
Ureum	14.1 mg/dl	15 – 40
Creatinine	0.55 mg/dl	0.0 – 0.9
Albumin	2.85 g/dl	3.97 – 4.94
GDS	100 mg/dl	80 – 139
Natrium	137 mmol/L	136 – 145
Kalium	4.0 mmol/L	3.6 – 5.2
Chlorida	113 mmol/L	97 – 108
Calcium	7.68 mmol/L	8.6 – 10.3

b. Ward Care

Hemodynamics of the patient during treatment in the ward:

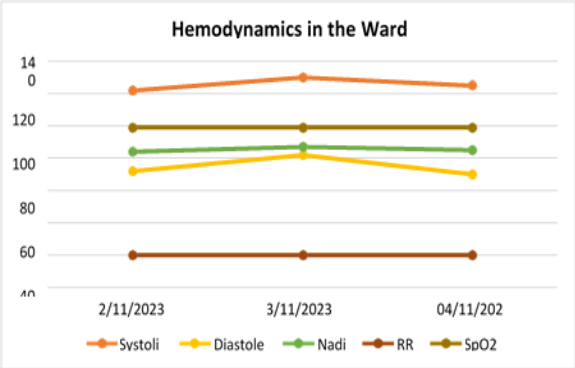

Figure 7. Monitoring Graph of Ward Care

Table 3. Therapy during Treatment in the ICU

Therapy given during treatment in the ward	
1-11-2023	2-11-2023
Ceftriaxone 2x1 gr	Ceftriaxone 2x1000mg
Ranitidine 2x50 mg	Ranitidine 2x50 mg
Dexamethasone 3x5 mg	Dexamethasone 3x5 mg
Antrain 3x1 gr iv	Antrain 3x1 amp
Paracetamol 3x1000 mg	Paracetamol 3x1 gr
Morphine 1 mg/hour pump	

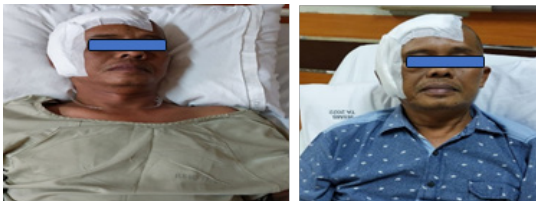

Figure 8. Clinical Postoperative Patients

Table 4. Therapy during Treatment in the Ward

Therapy given during treatment in the ward		
2-11-2023	3-11-2023	4-11-2023
IVFD NaCl 0,9% 20 drops/min	IVFD NaCl 0,9% 20 drops/min	IVFD NaCl 0,9% 20 drops/min
Ceftriaxone 2x1 gr	Ceftriaxone 2x1 gr	Ceftriaxone 2x1 gr
Ranitidine 2x50 mg	Ranitidine 2x50 mg	Ranitidine 2x50 mg
Dexamethasone 3x5 mg	Dexamethasone 3x5 mg	Dexamethasone 3x5 mg
Antrain 3x1 amp	Antrain 3x1 amp	Antrain 3x1 amp
Mannitol 4x100 cc	Mannitol 4x100 cc	Mannitol 4x100 cc
	Sit-in mobilization	Sit-in mobilization

III. Discussion

Rarely is CSM treatment urgent. It is generally preferable to wait until there is proof that a patient needs radiation, surgery, or both. Treatment options for mild symptoms, like mild diplopia in one's lateral vision, include lateral rectus muscle therapy or glasses correction. Surgery has a significant death and morbidity rate, particularly if it is drastic or aggressive. Some tumors can be slowed and shrunk by radiation therapy, although long-term side effects are possible. Thus, for the majority of patients, surgery or radiation therapy does not be the first priority to be done. Thus, the optimal period must be selected until either surgery, radiation, or both may be required, depending on the available data.

Neurosurgery is usually a long-term operation, so the drugs used for the maintenance of anaesthesia are essential.[1,6] The two most popular therapies for CSM are radiation therapy and surgery. Compared to other brain tumors, radical or aggressive tumor excision may be associated with a higher risk of death and morbidity. Without resulting in mortality, radiation therapy causes some patients' tumors to shrink or slow down in growth. But as will be covered later, there are issues linked to it as well. A serious side effect of tumors both with and without treatment is ophthalmoplegia. When selecting a course of treatment, its occurrence– regardless of the cause–must be taken into account. In addition to reduced vision ability, the resulting facial damage brings significant changes to the mentality and social life of patients.[2,7]

Effective neuroanesthesia involves avoiding problems with brain tissue, blood, and cerebrospinal fluid, among other intracranial components. Although the inhalation anesthesia approach is frequently used in neurosurgical care, the medicine has the ability to raise CBF and ICP by decreasing vascular resistance, particularly cerebral vascular resistance. The inhalation anesthesia approach will raise the intracranial pressure (ICP) in circumstances where it is already elevated. This will lower the ICP and raise the risk of cerebral ischemia, which might result in brain injury.[2,7]

An interesting new alternative for anesthesiologists to maintain general anesthesia is desflurane. Researchers are investigating the drug's potential benefits in brain surgery. According to a study of the literature, desflurane is a medication that is safe for cerebral hemodynamics. While certain clinical trials indicated that total intravenous anesthesia (TIVA) and inhaled anesthesia are linked to similar levels of brain relaxation in patients having elective craniotomy for brain tumors, the majority of these research only consider sevoflurane and isoflurane, ignoring desflurane. Quick recovery is possible using desflurane, an inhaled anesthetic with low blood solubility that can help detect surgical problems early on, such as hematoma formation, acute cerebral infarction, and neurological impairments. Notwithstanding these advantages, there has been discussion over desflurane's stronger impact on cerebral vasodilation during neurosurgery, which may result in inadequate brain relaxation because of elevated CBF.[3,4]

The use of propofol/dexmedetomidine and analgesic medications (fentanyl or remifentanil) in total intravenous anesthesia techniques can lower cerebral metabolic rate of oxygen (CMRO2), lower ICP, maintain brain perfusion pressure, and reduce CBF—a process known as "Coupling Flow Metabolism"—all of which help to protect brain tissue from damage. The neuroanesthesia management of craniotomy surgery in meningioma elective surgery will be covered in this case study. The difficulties this case presents to neurosurgeons and neuroanesthesiologists make it intriguing. How a neurosurgeon manages bleeding and improves the result. Maintaining appropriate cerebral perfusion pressure (CPP), lowering CBF, preserving normal autoregulation, lowering cerebral metabolic rate of oxygen (CMRO2), setting aside enough cerebral delivery oxygen (CDO2), and loosening and relaxing brain tumors are the ways that neuroanesthesia management maintains stable hemodynamics.[2,5]

Intravenous anaesthetic drugs that can reduce ICP and CBF from the class of induction drugs are thiopental, propofol, etomidate, and midazolam. Propofol can cause hypotension,

hypertriglyceridemia, and propofol infusion syndrome. Nevertheless, propofol is an effective drug for regulating intracranial pressure (ICP). It can reduce the metabolic rate of the brain by 40% by relying on the dose and reducing cerebral blood flow. Of all the classes of induction drugs mentioned, the most commonly used option is thiopental. Thiopental is one of the intravenous anaesthetics belonging to the barbiturate group. In this case, the patient was given thiopental because the onset of thiopental action is very short. Thiopental dosages administered intravenously may results in an increase in heart rate and a drop in blood pressure. Thiopental will lower cardiac output and arterial pressure at large doses.[2,7]

When used as an analgesic, sufentanil is an opioid with a quick onset and strong analgesic potential. For instance, intravenous sufentanil is 5–10 times more potent and 3–5 times more potent in the extradural area than fentanyl. The primary reasons for its effectiveness are its high lipid solubility and blood-brain barrier-crossing capability. It is well known that medications that paralyze muscles raise CBF; however, vecuronium and rocuronium are the least known to do so, making them the preferred medications for neurosurgical procedures. Patient weighing 67 kg was given 50 mg of rocuronium in this case. Since rocuronium is a competitive muscle-paralyzing medication with the quickest start of effect–two to three minutes–and a medium duration of action, it was selected in this particular instance. Rocuronium has very little effect on the heart. Rocuronium has a little vagolytic action at high doses. The liver and, to a lesser extent, the renal system remove rocuronium.[8] 40% water and 60% oxygen make up the 4% desflurane inhalation anesthesia utilized in this procedure.

The PaO_2 pressure cannot rise above 200 mmHg, so 60% oxygen flow is used. N_2O is not administered to these individuals since it may directly promote brain blood vessel vasodilation and raise CBF; however, hyperventilation ($PaCO_2$ 30–35 mmHg) may mitigate this impact. According to certain research, N_2O can cause the endoplasmic reticulum and mitochondria to vacuolate while having no protective impact on brain neurons. Complete disinhibition of GABA receptors can also be brought on by N_2O. Using N_2O can degenerate the spinal cord and prevent cells from electrophysiologically recovering in patients with folic acid deficiency. When N_2O is mixed with other inhaled anesthetics, though, the side effects can be differ, either with or without hypocapnia.[2] Desflurane affects the lipid membrane of the nerve bilayer, disrupting nerve synaptic transmission. The agent also blocks excitatory ion channels and increases inhibitory ion channel activity. Desflurane has the lowest blood/gas solubility of 0.42 compared to other general anaesthetic agents. This allows the alveolar concentration of the anaesthesia to remain close to the inspiratory concentration, resulting in precise and predictable control over the depth of the anaesthesia.[9,10]

The emphasis on low-flow gas techniques has become more important, especially in long-term operations, because the need for anaesthesia in neurosurgery changes rapidly as the surgical stimulus constantly changes. Desflurane produces almost negligible fluoride ions, which is one of the compelling reasons to choose it over sevoflurane. Desflurane decrease intraoperative hypotension, with no hypertensive episodes than sevoflurane. Desflurane administration does not change the heart rate from baseline, with a much faster return of arterial blood pressure at the end of anaesthesia. Reasonable arterial blood pressure control is necessary for brain and spine surgery. Desflurane can maintain tighter arterial blood pressure control than isoflurane in patients undergoing spinal surgery who requires moderate arterial.[11]

The fact that desflurane has been shown in multiple research is its most significant benefit. The two most feared adverse effects, cerebral oedema and hematoma formation, must be taken into account as soon as possible. Patients recovery following anesthesia with desflurane and sevoflurane were assessed using Rancho Los Amigos scale and a short-orientation memory attention test to study cognitive function. Furthermore, patterns of gas exchange (pH, PaO_2, and $PaCO_2$) were noted. The following minutes are recorded: 15, 30, 45, and 60. Cognitive values

returned to baseline in the desflurane group in 30 minutes, while those receiving sevoflurane experienced a 45-minute recovery in cognitive function. Additionally, the authors observed that patients receiving sevoflurane had lower pH levels up to 45 minutes after extubation and greater $PaCO_2$ at 15 and 30 minutes. A speedier return to normocapnia and normal pH was seen in the desflurane group. In neurosurgical patients, variations in postoperative gas exchange patterns and cognitive recovery are clinically beneficial because they reduce cerebral hyperaemia linked to hypercarbia and enable early detection in the event that difficulties arise after surgery. According to certain research, desflurane recovery occurs fifteen minutes faster than sevoflurane recovery. This could affect the surgeon's decision to ask for a computed tomography scan if the nerve evaluation isn't good enough.

We used desflurane in this patient because desflurane has a cerebral vasodilation effect, to compensate for this effect, we used thiopental which has a cerebral vasoconstriction effect.[8,12] In this patient, furosemide was not given because brain tissue had been visibly loose with mannitol administration. Placing the patient's head at a temperature of between 15 and 30 degrees Celsius was another way to stop their ICP from rising. For every 10°C drop in temperature, there can be a 5% reduction in cerebral blood flow due to mild hypothermia, which is defined as a temperature between 33 and 35°C. The patient's head was kept supine, neutral, not tipped to the left or right, and not overextended following surgery. Both blood pressure and hematocrit were kept close to 33% and within the bounds of automated management.[8, 13]

IV. Conclusion

Cavernous sinus meningiomas (CSMs) with orbital involvement present unique challenges for modern neurosurgeons. In neuroanesthesia management, the way to maintain stable hemodynamics is to maintain adequate CPP, reduce CBF, maintain normal autoregulation, lower CMRO2, keep CDO2 suffice, and make cerebral tumours lose and relaxed. Rocuronium shows benefit in this patient because of fast action of competitive muscle-paralyzing effect, 2-3 minutes, with a medium duration of action. Moreover, it has minimal cardiovascular effects.

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