JNI Jurnal Neuroanestesi Indonesia

Case Report

Dexmedetomidine as Neuroanesthesia Management in Patient with Meningioma Craniotomy

Mohammad Aji Kumoro, MM Rudi Prihatno, Aditya Pradana Kartinofan
Department of Anesthesiology and Intensive Therapy, Faculty of Medicine Universitas Jenderal Soedirman–Prof. Margono Soekarjo General Hospital, Purwokerto, Indonesia
Received: March 2, 2024; Accepted: June 12, 2024; Publish: June 27, 2024
correspondence: portio_co@yahoo.co.id

Abstract

Meningiomas are the type of tumour that grows from the protective membranes of the brain, which line both the brain and spinal cord. The incidence rate of meningioma between females and males is 2:1 and tt is a fairly common neurosurgical case at Margono Soekarjo General Hospital Purwokerto. Dexmedetomidine is the drug of choice used for sedation and analgesia. In various literature, it is said that the use of dexmedetomidine will reduce hemodynamic fluctuations during surgery. A 49-year-old man was hospitalized because of cephalgia and hemiparesis of his left extremity. Computed tomography scan revealed a solid tumour at parietooccipitalis region, lobulated, measuring 7,2 x 7,1 x 4,4 cm, and an increase in intracranial pressure. General anesthesia was administered, beginning with premedication using sufentanil for analgesia, followed by induction with thiopental, and rocuronium for muscle relaxation to facilitate intubation. Dexmedetomidine is an attractive option available for anesthesiologist for maintaining general anesthesia. In this surgical procedure to remove an intracranial tumor, appropriate induction and monitoring of the patient's condition during surgery is required to prevent the risk of increasing intracranial pressure. Dexmedetomidine reduces cerebral blood flow, decreases intracranial pressure, reduces the rate of cerebral oxygen metabolism, and maintains cerebral perfusion pressure. Good management of neuroanesthesia supports the maintenance of hemodynamic stability and leads to better outcomes in craniotomy surgery. Dexmedetomidine has benefits on maintenance of anaesthesia in neurosurgical procedures.

Keywords: Meningioma, dexmedetomidine, anaesthesia management

J. neuroanestesi Indones 2024;13(2): 93–8

I. Introduction

Meningiomas are a significant challenge to neurosurgeons globally due to their potential malignancy, as well as the expectation of achieving an ideal surgical outcome following complete excision. Meningiomas are the type of tumour that grows from the protective membrane of the brain, called the meninges, which line the brain and spinal cord. Meningiomas arise from the arachnoidal cells of the leptomeninges and can occur anywhere, especially in the arachnoid cell section. The general classification of meningiomas based on WHO criteria is divided into three groups: benign meningiomas (WHO Grade I), atypical meningiomas (WHO Grade II), and anaplastic (malignant) meningiomas (WHO Grade III). Meningiomas can occur at any age more frequently in adults, with the peak decade being 5 years of life. The ratio of meningioma incidence between female and male is 2:1.[1]

The intracranial component consists of brain tissue, blood, and cerebrospinal fluid. The volume composition of these three components can change according to Monroe Kellie's law, while the total volume remains constant since intracranial volume remains unchanged.[2,3]

doi: https://doi.org/10.24244/jni.v13i1.592
ISSN (Print): 2088-9674 ISSN (Online): 2460-2302

JNI is accredited as Sinta 2 Journal: https://sinta.kemdikbud.go.id/journals/profile/796

How to cite: Kumoro MA,, et al, "Neuroanesthesia Management with Dexmedetomidine in Meningioma Craniotomy".

Hence, an increase in the volume of one component leads to a decrease in the volume of the other components.[4] Effective neuroanesthesia involves preventing disruption of each intracranial component. Inhalational anesthesia techniques have gained widespread acceptance in neurosurgical management, but they can decrease vascular resistance, especially cerebral vascular resistance, and leading to elevated cerebral blood flow and intracranial pressure.[5]

The total intravenous anesthesia technique using propofol/ dexmedetomidine along with analgesic medications like remifentanil or fentanyl can effectively decrease cerebral blood flow, diminish intracranial pressure, sustain brain perfusion pressure, and reduce the cerebral metabolic rate of oxygen ($CMRO_2$). This approach, known as "Coupling Flow Metabolism," aims to safeguard brain tissue from potential damage. The use of dexmedetomidine in neurosurgical surgery has several advantages over other anaesthetic drugs. Various literature indicates that the use of dexmedetomidine reduces hemodynamic fluctuations due to intubation, extubation, and results in a more comfortable recovery of consciousness.[6] This case report examines the effect of using Dexmedetomidine for maintenance meningioma surgery, which is expected to give better results than other anaesthetic agents.

II. Case

History

The patient complained of worsening headaches for over the last 2 months, and was admitted to the neurosurgery clinic in October 2023. The patient reported blurred vision, impaired hearing, weakness of left extremities, no complain of slurred speech, olfactory disorders are denied, and there was no history of fainting or seizures. A CT scan confirmed the presence of a meningioma. The patient denied any history of allergies and other systemic diseases including diabetes mellitus, CVA, and hypertension. The patient had undergone previous meningioma craniotomy surgery in August 2023 at other health facility.

Physical Examination

During the physical examination, the patient was observed to have a Glasgow Coma Scale (GCS) score of E4V5M6. The results of the vital signs examination were within normal limits with blood pressure 118/81 mmHg, pulse 75x/ minute with regular pressure, respiratory rate value 20x/minute, SpO_2 97% and the patient's body temperature 36.8°C. The anthropometric assessment showed a body weight of 65 kg and a height of 167 cm, resulting in a Body Mass Index (BMI) value of 23.3 kg/m².The results of the head examination showed a mesocephalic impression, there were no anemic conjunctiva or icteric sclera. In the oral cavity examination, no presence of missing teeth were noted and the mallampati score was two. No masses or enlarged lymph nodes were found on neck examination. On chest examination, normal movement was found and there were no retractions, lung and heart sounds were within normal limits. Abdominal and extremity examinations were within normal limits. The patient underwent further supporting examinations including laboratory examinations, electrocardiogram (ECG), chest x-ray and head CT scan using contrast. The CT scan of the head revealed of presence of a solid mass with central necrosis and perifocal edema in the right parietooccipital lobe, measuring 7.2 x 7.1 x 4.4 cm in size. There was bilateral lateral ventricular compression and displacement of the third ventricle to the left (status quante), with indications of increased intracranial pressure.

The patient's vital signs when taken to the operating room are as follows: blood pressure 128/95 mmHg, pulse rate 78x/minute, respiratory rate 18x/minute, body temperature 36.6 °C, and SpO_2 99%. General anesthesia was induced to the patient using no. 7.5 non-kinking endotracheal tube with a semi-closed breathing control system. Premedication includes ondancentron 4 miligram intravenously, dexamethasone 5 miligram intravenously, preemptive analgesia sufentanil 15 microgram intravenously, thiopental induction 250 miligram intravenously, muscle relaxant rocuronium 40 miligram intravenously, fresh gas flow (FGF) 3 L/minute, maintenance sevoflurane 2% with a ratio of O_2 50% and aquadest 50%, VT 400 mililiter, RR 15x/minutes, MV 6000

Preoperative Supporting Examination

Table 1. Results of Laboratory Tests

Laboratory	Result	Normal Values
Hemoglobin	14.2 g/dl	10.9 – 14.9
Hematokrit	44 %	34 – 45
Leukosit	11250/mm3	4790 – 11340
Platelets	228000/µL	216000 – 451000
Ureum	24.8 mg/dl	15 – 40
Creatinine	0.49 mg/dl	0.0 – 0.9
Albumin	-	3.97 – 4.94
PT	12.3 seconds	11.7 – 15.1
APTT	25.8 seconds	28.6 – 42.2
SGOT	44.4 U/L	< 31
SGPT	24.0 U/L	< 31
Blood sugar	146 mg/dl	80 – 139
Natrium	133 mmol/L	136 – 145
Potassium	3,9 mmol/L	3.5 – 5.1
Chloride	101 mmol/L	97 – 107
Calcium	8.41 mg/dl	8.6 – 10.3
HBsAg	Non-reactive	Non-reactive

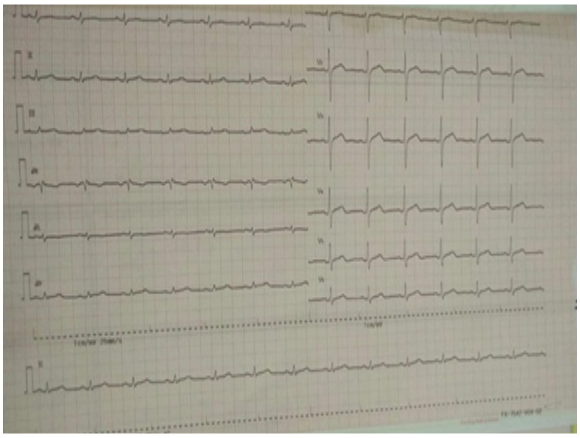

Figure 1. ECG Examination

mililiter, syringe pump rocuronium 10 mg/hour intermittent, and syringe pump dexmedetomidine 10 cc/hour.

The Computerized Tomography scan of the head revealed a solid mass with central necrosis and perifocal edema in the right parietooccipitalis lobe, measuring 7.2 x 7.1 x 4.4 cm in size, that causes bilateral lateral ventricles compression and

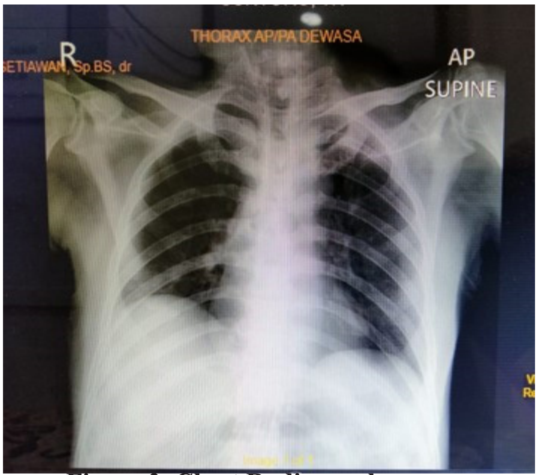

Figure 2. Chest Radiography

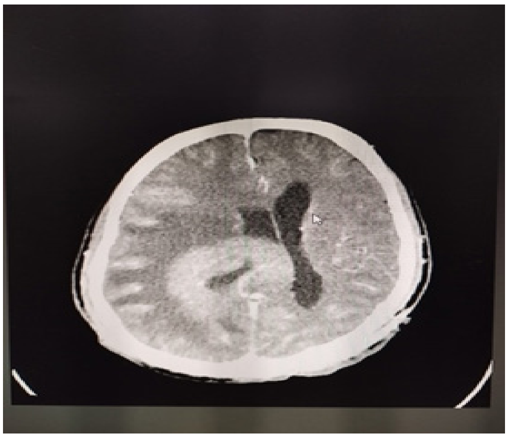

Figure 3. Computerized Tomography Scan Examination of the head with contrast

ventricle III compression to the left (status quante). Based on the results of a CT scan of the head, there is a risk of increased intracranial pressure.

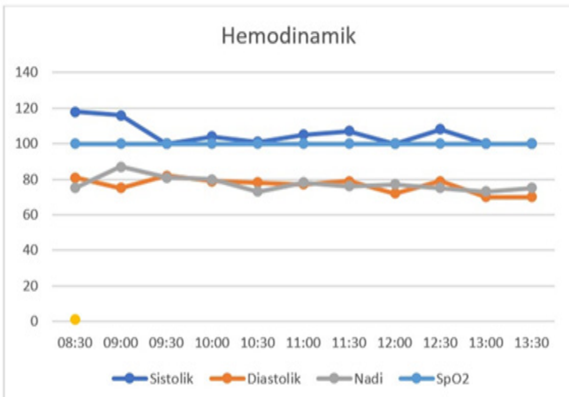

Figure 4. Hemodynamic Monitoring Chart Durante Surgery

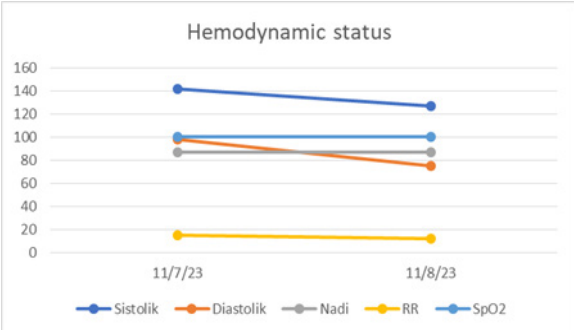

Figure 5. Monitoring Graph of Care in the Intensive Care Unit (ICU)

The table below shows post-operative laboratory results during patient care in the Intensive Care Unit:

Table 2. Laboratory Results in the Intensive Care Unit

Laboratory	10/23/2023	Normal Values
Hemoglobin	13.5 g/dl	10.9 – 14.9
Hematocrit	43 %	34 – 45
Leukosit	8400/mm3	4790 – 11340
Platelets	261000/µL	216000 – 451000
Ureum	22.1 mg/dl	15 – 40
Creatinine	0.36 mg/dl	0.0 – 0.9
Albumin	2.84 g/dl	3.97 – 4.94
GDS	138 mg/dl	80 – 139
Natrium	137 mmol/L	136 – 145
Potassium	3.9 mmol/L	3.5 – 5.1
Chloride	110 mmol/L	97 – 107
Calcium	8.06 mmol/L	8.6 – 10.3

Therapy given during treatment in the ICU:
The table below describes the therapy given during patient's care in the Intensive Care Unit.

Table 3. Therapy in the Intensive Care Unit

10/23/2023	11/02/2023
Bactesyn 3x1,5 gr iv	Bactesyn 3x1,5 gr iv
Ranitidine 2x50 mg iv	Ranitidine 2x50 mg iv
Phenytoin 4x100 mg iv	Dexametason 3x5 mg iv
Tranexamic acid 3x500 mg iv	Tranexamic acid 3x500 mg iv
Paracetamol 3x1 gr iv	Paracetamol 3x1 gr iv
Morphine 1 mg/hour pump	Furosemide 2x20 mg iv

III. Discussion

Effective neuroanesthesia management includes preventing disorders affecting each intracranial component, including brain tissue, blood, and cerebrospinal fluid.[2] Although inhalation anesthesia techniques have become widely accepted in neurosurgical management, this treatment may reduce vascular resistance, especially cerebral vascular resistance. This reduction often resulted in elevated cerebral blood flow (CBF) and intracranial pressure (ICP). In cases of elevated intracranial pressure, the use of inhalation anaesthesia technique will make the pressure higher and increase the risk of cerebral ischemia and potentially resulting in brain damage.[2] Intravenous anaesthetic drugs that can reduce intracranial pressure and cerebral blood flow are thiopental, propofol, etomidate, and midazolam. In this case, thiopental is the drug of choice because the time of action is very short. Thiopental can cause a risk of decreased blood pressure and increased heart rate. . In high doses, thiopental can cause a decrease in arterial pressure and cardiac output.[7]

Administering Sufentanil as an analgesic offers advantages due to its rapid onset and potent opioid properties.[8] While muscle relaxant drugs are known to increase cerebral blood flow (CBF), vecuronium and rocuronium are recognized for increasing of CBF at least.[9] Consequently, they are favored as the preferred drugs for neurosurgical procedures.In this case, patients weighing 49 kg were administered 40 mg of rocuronium.[8] The inhaled anesthesia used is 1–2% sevoflurane with an oxygen-to-air ratio of 60% to 40%. The 60% oxygen flow rate is administered to prevent PaO_2 levels from surpassing 200 mmHg. In these patients, N_2O is not given because it can cause vasodilation of cerebral blood vessels and elevate cerebral blood flow (CBF). However, this effect can be mitigated by inducing hyperventilation to maintain $PaCO_2$ levels between 30–35 mmHg.

Dexmedetomidine is a highly selective α-2 adrenoreceptor agonist with sympatholytic, sedative, amnestic and analgesic properties, but without respiratory depression. It has been considered a useful and safe adjunct to anaesthesia for various surgical procedures. A number of systematic reviews and meta-analyses have shown that dexmedetomidine reduces postoperative pain intensity and has an opioid-sparing effect, with less postoperative nausea and vomiting (PONV), shorter ICU stay and faster recovery across different types of surgery. Several pre-existing meta-analyses have reported that dexmedetomidine reduces perioperative opioid consumption and postoperative pain in patients undergoing neurosurgery with better hemodynamic control and fewer postoperative antiemetic requests.[6]

Administration of α-2 agonist drugs can reduce the need for anaesthesia use because the sympatholytic component is able to maintain hemodynamic stability during surgery.[10] Presynaptic stimulation of α-2 receptors can reduce norepinephrine release and postnatal α-2 receptor activation hyperpolarizes neuronal membranes. Activation of receptors in the brain and brainstem causes hypotension, bradycardia, sedation and analgesia. In other literature it is said that the use of dexmedetomidine will reduce hemodynamic upheaval due to more comfortable intubation, extubation and recovery of consciousness. Faster postoperative recovery of consciousness is also the basis for choosing dexmedetomidine in neuroanesthesia. This can be seen from the length of stay in the ICU which is only one day for this patient.

IV. Conclusion

Meningiomas pose a challenge to neurosurgeons due to their malignancy, and the expected perfect surgical outcome after total excision. In neuroanesthesia management, maintaining stable hemodynamics involves ensuring adequate cerebral perfusion pressure, reducing cerebral blood flow (CBF), preserving normal autoregulation, lowering cerebral oxygen metabolic rate. Thiopental was administered to this patient due to its rapid onset of action, which can effectively decrease intracranial pressure (ICP) and cerebral blood flow (CBF). Rocuronium was selected in this operation because it is a competitive muscle relaxant agent with the fastest onset of action, usually within two-three minutes with a moderate duration of action and minimal cardiovascular effects. Dexmedetomidine is a new type 2 adrenergic receptor (2-AR), which selectively bind to adrenergic receptors 1 and 2, playing a dual role by restraining sympathetic nerve activity and stimulating the vagus nerve. Dexmedetomidine also plays an important role in sedation, analgesia and hemodynamic stability10. Dexmedetomidine can effectively reduce the brain damage caused by craniotomy, exerting a protective effect in the brain through the management of hemodynamic stability, and suppression of inflammation.

References

1. Dube SK, Pandia MP, Chaturvedi A, Bithal P, Dash HH. Comparison of intraoperative brain condition, hemodynamics and postoperative recovery between desflurane and sevoflurane in patients undergoing supratentorial craniotomy. J Saudi Anaesth. 2015;9(2): 167–73. Doi: 10.4103/1658-354X.152866

2. Bisri DY, Bisri T. Dasar-Dasar Neuroanestesi.. Faculty of Medicine, Padjadjaran University. Bandung. 2019.

3. Butterworth JF, Mackey DC, Wasnick JD. Morgan and Mikhail's Clinical Anesthesiology. New York: Mc Graw Hill. 2007.

4. Gropper MA, Eriksson LI, Fleisher LA, Leslie K, Wiener-Kronish JP, Cohen NH, et al. editors, Miller's Anesthesia. 9th ed. Elsevier Inc. 2020.

5. Zhou Z, Ying M, Zhao R. Efficacy and safety of sevoflurane vs propofol in combination with remifentanil for anesthesia maintenance during craniotomy. Medicine. 2021; 100(51): 1–8. Doi: 10.1097/MD.0000000000028400

6. Permatasari E, Suarjaya IPP, Saleh SC, Wargahadibrata AH. Penggunaan dexmedetomidin untuk operasi meningioma

petroclival dengan intraoperatif neurophysiological monitoring. J neuroanestesi Indonesia. 2017; 6 (1): 34-41. Doi: https://doi.org/10.24244/jni.vol6i1.35.

7. Gracia CJ, Hanafie A, and Nasution AH. Comparison of hemodynamic response between propofol and thiopental as an induction agent in neurosurgery anesthesia at Haji Adam Malik General Hospital Medan-Indonesa. Bali Med J. 2018;7(3):717–22

8. Kulsum, Suryadi T. Neuro-anesthetic management of craniotomy-surgery in removal tumor multiple meningioma patients: A case report. Open Access Macedonian J Med Sci. 2021;9(C):146–50

9. Nguyen A, Mandavalli A, Diaz MJ, Root KT, Patel A, Casauay J, et al. Neurosurgical anesthesia: Optimizing outcomes with agent selection. Biomedicines. 2023; 11(2): 372. Doi: 10.3390/biomedicines11020372

10. Su S, Ren C, Zhang H, Liu Z, Zhang Z. The Opioid-Sparing effect of perioperative dexmedetomidine plus sufentanil infusion during neurosurgery: a retrospective study. Front Pharmacol. 2016;7:407.