Neuroanesthesia Management of Complex Meningioma Case: A Comprehensive Approach for Minimizing Edema and Bleeding

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ABSTRACT

Introduction: Meningioma is an extra-axial tumor originating from the arachnoid membrane cells. Most meningiomas are benign, circumscribed, slow growing and can be treated surgically according to the location of the lesion. The three main symptoms are headache, altered mental status and paralysis.

Case illustration: This case report discusses about A 41-year-old female patient came in conscious condition complaining of head pain that had been complaining since 2 years ago accompanied by complaints of nausea, vomiting and tonic-clonic seizures which were complained of 1 day before surgery. MRI examination of the brain with contrast, suggest a solid mass stinging firm contrast, dural tail is present, accompanied by perifocal edema measuring 4 x 4.1 x 4 cm in the right sphenoid wing urging the brainstem and midline to the left as far as 0.6 cm, depressing the optic chiasma and extending to the cavernous sinus tract right optic view shows a meningioma. The patient was managed under general anesthesia and lumbar drainage to reduce perioperative intracranial pressure.

Conclusion: Various neuroanesthesia approaches including patient positioning, optimal neuroanesthesia management are needed so that oedema and bleeding from surgery can be minimized.

Keywords: Meningioma; neuroanesthesia; sphenoid wing

Manajemen Neuroanestesi pada Kasus Meningioma Kompleks: Sebuah Pendekatan Komprehensif untuk Mengurangi Edem Serebri dan Perdarahan

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ABSTRAK

Pendahuluan: *Meningioma merupakan suatu tumor ekstra aksial yang berasal dari sel selaput araknoid. Kebanyakan meningioma bersifat jinak, terbatas, berkembang lambat dan dapat ditangani dengan pembedahan sesuai lokasi lesi. Tiga gejala utama yang sering terjadi yaitu nyeri kepala, perubahan status mental, dan kelumpuhan.*

Ilustrasi Kasus*: Pada laporan kasus ini membahas mengenai pasien wanita berusia 41 tahun yang datang dalam kondisi sadar, mengeluh nyeri kepala hilang timbul sudah sejak 2 tahun yang lalu disertai dengan keluhan mual, muntah dan kejang tonik-klonik yang dikeluhkan terjadi 1 hari sebelum dilakukan operasi. Hasil pemeriksaaan Magnetic Resonance Imaging (MRI) kepala dengan kontras mengesankan massa solid menyengat kontras batas tegas, dural tail ada, disertai perifokal edema ukuran 4 x 4,1 x 4 cm di sphenoid wing kanan mendesak brainstem dan midline ke kiri sejauh 0,6 cm dan mendesak kiasma optikum dan meluas ke sinus cavernosus traktus optikus kanan mengarah ke gambaran meningioma. Pasien dilakukan manajemen anestesi umum dan lumbal drainase untuk menurunkan tekanan intracranial perioperative.*

Simpulan: *Sangat diperlukannya berbagai pendekatan neuroanestesi mencakup posisi pasien, manajemen neuroanestesi yang optimal sehingga edema dan perdarahan dyrante operasi dapat diminimalkan.*

Kata Kunci: *Meningioma; neuroanesthesia; sphenoid wing*

INTRODUCTION

Meningiomas are a challenge for neurosurgeons worldwide due to their benign nature and the expectation of a perfect postoperative outcome after complete removal. Meningioma is an extra-axial tumor originating from the arachnoid membrane cells. It can occur at any age, but is most common in the elderly. The incidence of meningioma in women is higher than men, with a ratio of 2:1 in the intracranial area and 10:1 in the spine. Most meningiomas are benign, circumscribed, slow-growing and can be managed surgically according to the location of the lesion. The most common location is in the parasagittal region. The three main symptoms are headache, altered mental status and paralysis. In addition to facilitating surgery, anesthetists also need to perform the best neuroanesthesia technique that can control intracranial pressure, protect nerve tissue from injury and ischemia by maintenance "brain protection" techniques, and reduce the amount of bleeding that occurs during surgery. There are several things that are important to avoid during surgery such as hypoxemia, hypercapnia, anemia and hypotension as they will negatively affect the central nervous system and the outcome of the surgery. In order to prevent these, it is important to maintain cerebral autoregulation and the response to CO_2. Cerebral blood flow (CBF) is maintained constant at a mean arterial pressure (MAP) of 50-150 mmHg. Beyond this limit, even with maximal dilation or maximal contraction of the cerebral blood vessels, CBF will passively follow the cerebral perfusion pressure (CPP). When CBF is severely reduced (MAP < 50 mmHg) cerebral ischemia may occur. Above the normal limit (MAP > 150 mmHg), the pressure will damage the contraction force of blood vessels and CBF will rise suddenly. There is a breakdown of the blood-brain barrier and cerebral oedema and possibly cerebral hemorrhage occur. There are three intracranial components: brain tissue, blood and cerebrospinal fluid. The volume composition of the three components can change according to Monroe Kellie's law, but the total volume is always constant because the intracranial volume is always the same. Therefore, an increase in the volume of one component will be followed by a decrease in the volume of the other component. Good neuroanesthesia technique are needed including prevention of disturbances in each of the intracranial components. In this case report, we will discuss the management of neuroanesthesia in a patient with a brain tumor who underwent craniotomy for tumor removal.[1,2]

CASE ILLUSTRATION

A 41-year-old female patient, weighing 55 kg and standing 160 cm tall, presented in a conscious state, complaining of worsening headaches. She had experienced intermittent headaches for the past two years, accompanied by nausea, vomiting, and tonic-clonic seizures, which occurred one day before the scheduled surgery. The patient had no history of asthma, hypertension, cardiovascular disease, diabetes, or other systemic conditions. She also denied any drug or food allergies, as well as a history of smoking or alcohol consumption. As a housewife, her daily physical activities were limited due to persistent headaches. She also denied experiencing chest pain or shortness of breath during strenuous activities.

During the pre-anesthesia physical examination in the ward, the patient was compos mentis with a Glasgow Coma Scale (GCS) score of E4V5M6. The pupils were round, anisocoric with measurements of 4 mm/3 mm, and light reflexes were positive in both eyes. Ptosis was noted in the right eye, and bitemporal hemianopsia was observed. Blood pressure was 110/70 mmHg, with a regular pulse rate of 74 beats per minute that was strongly palpable. Heart sounds (S1 and S2) were single, regular, without murmurs or gallops. The respiratory rate ranged from 14 to 16 breaths per minute, with vesicular breath sounds and no rhonchi or wheezing. Axillary temperature was 36.2°C. Abdominal examination revealed no abnormalities. The extremities were warm, with no edema, cyanosis, or jaundice. Motor strength was 5/5 in both the upper and lower extremities on the right and left sides, and sensory function in both upper and lower extremities was normal. Proprioceptive and autonomic functions (piloerector, sudomotor, vasomotor) were within normal limits.

A 41-year-old female patient, weighing 55 kg and standing 160 cm tall, presented in a conscious state, complaining of worsening headaches. She had experienced intermittent headaches for the past two years, accompanied by nausea, vomiting, and tonic-clonic seizures, which occurred one day before the scheduled surgery. The patient had no history of asthma, hypertension, cardiovascular disease, diabetes, or other systemic conditions. She also denied any drug or food allergies, as well as a history of smoking or alcohol consumption. As a

Table 1. Pre-operative laboratory examination results

Parameter	Result	Parameter	Result
Haemoglobin	12.8 g/dl	Sodium	142 mEq/L
Hematocrit	37.5%	Potassium	3.6 mmol/L
Leukocytes	6.43 x 10 /µL^3	Chloride	110 mmol/L
Platelets	368 x 10 /µL^3	BUN	5.8 mg/dL
PPT	14.1 seconds	SC	0.67 mg/dL
APTT	32.3 seconds	SGOT	18.4 U/L
INR	1.00	SGPT	21.9 U/L

In anesthesia management, patient was diagnosed with extra axial tumor et causa suspect sphenoid wing meningioma dextran. The patient was concluded with the American Society of Anesthesiology three of physical status with central nervous system problems: extra-axial tumor of cerebropontine angle region dextran et causa suspect vestibular schwannoma dd meningioma, non-communicable hydrocephalus with symptom of increased intracranial pressure (ICP), in the form of tonic-clonic seizures and headache with level of consciousness GCS E4V5M6. Preparations before surgery are filling and signing informed consent, fasting 8 hours preoperatively, STATICS preparation in the operating theater, anesthetic and emergency drugs, infusion warmer, blood components, two large bore IV lines, arterial line, etCO_2, vasopressor drugs, anti-arrhythmia drugs, blanket warmer, CVC set, blood components, ICU and ventilator.

Patient was prepared in the operating room, position was supine with a neutral 30° head up position, ensure the neck is free. The patient was given volunteer hyperventilation by asking the patient to breathe normally for three minute while being given 100% oxygen through a facemask. The patient was given intravenous fentanyl 0.5 mcg/kg equivalent to 25 mcg and Propofol TCI Schneider mode with a target effect of 0.5 – 1 mcg/ml while preoxygenation was given. Airway and hemodynamics were maintained. After the patient was sedated, an artery line was inserted with a previous Allen test and infiltration of 2% lidocaine local anaesthetic. Induction was performed by given 150 mcg fentanyl intravenously, followed by the administration of propofol mode TCI Schneider with target effect 5 mcg/ml, dexmedetomidine with a dilution of 4 mcg/ml given in maintenance titration dose of 0.2 – 0.7 mcg/kg/hour. After the patient asleep, rocuronium 50 mg intravenously was given, the the patient was given a positive ventilation assisted with 100% oxygen fraction. Intubation was performed using a macintosh laryngoscope, followed by insertion of endotracheal tube (ETT) sized 7.5 with cuff, intravenous lidocaine 1 – 1.5 mg/kg IV (60 mg IV) was given before laryngoscopic intubation. Maintenance anesthesia with TCI Propofol, mode Schneider target effect 2 – 4 mcg/ml; rocuronium intermittent 0.1 mg/kg every 45 – 60 minutes, fentanyl intermittent 0.25 mcg/kg every hour, dexmedetomidine maintenance 0.2 – 0.7 mcg/kg/hour.

Lumbar drainage was performed by removing 30 ml of cerebrospinal fluid to reduce intracranial pressure during the surgery. Monitoring during surgery was evaluate systolic, diastolic, mean arterial blood pressure; end tidal CO_2, oxygen saturation, ECG waveforms, urine production through the urine catheter. The operation lasted

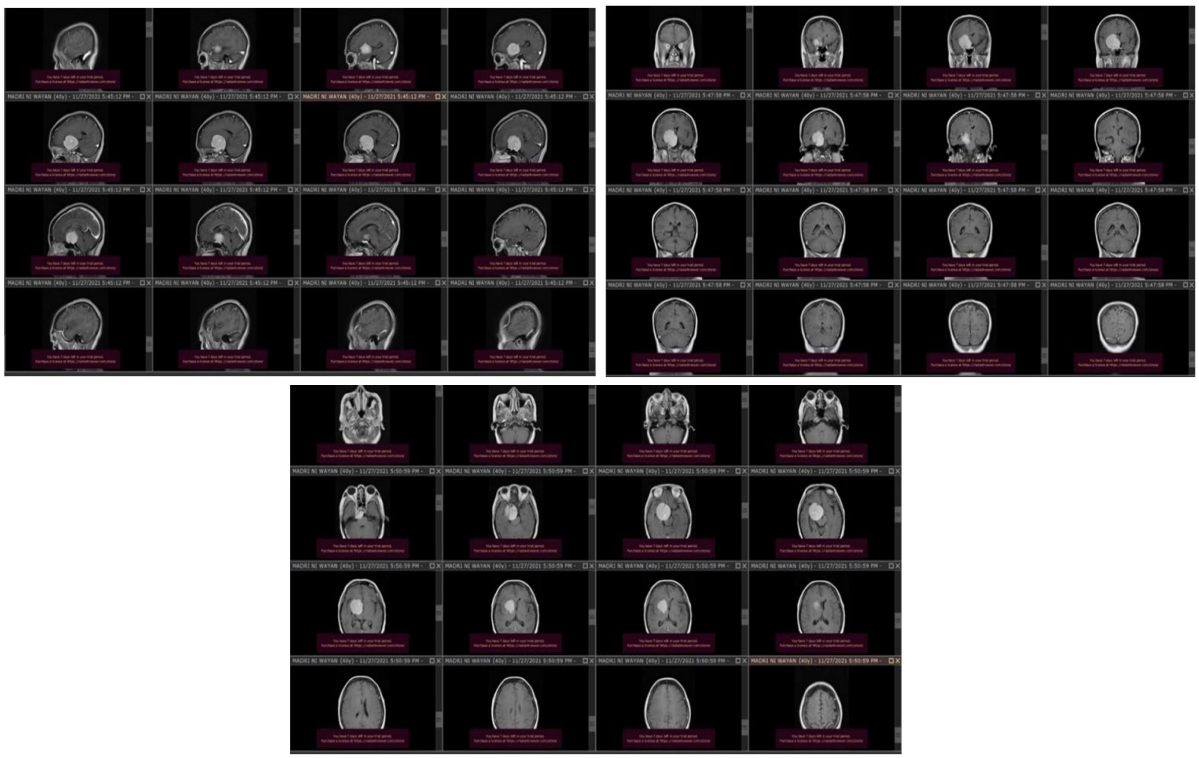

Figure 1. Head MRI with contrast

for six hours and fifteen minutes, with the patient in supine position.

The patient received 30 grams of mannitol before the cranium was opened. During the operation, the total amount of bleeding was 700 ml and diuresis was 2500 ml. The patient received 2000 ml crystalloid, 500 ml colloid, 1000 mg tranexamic acid and 10 mg dexamethasone. Surgery was performed for 6 hours 15 minutes with a pterional approach, when the periosteum was opened, the dura did not appear tense and when the dura was opened, the slack brain appeared. Tumor excision was performed with the aid of a microscope. Duramater and other layers were closed until the operation was completed. Hemodynamics during surgery with fluctuations in blood pressure 90-122 / 55-65 mmHg, pulse rate 56-78 beats per minute, respiration rate 12-14 beats per minute, oxygen saturation 99-100%. Postoperative extubation was performed in the operating room.

After the surgery, the patient was extubated

Figure 2. Patient Position

Table 2. Post-operative laboratory examination results

Parameter	Result	Parameter	Result
Hemoglobin	11 g/dl	pO_2	192 mmHg
Hematocrit	33.6 %	pCO_2	32 mmHg
Leukocytes	6.67 x 10 /µL^3	BE	-2.5 mmol/L
Platelets	306 x 10 /µL^3	HCO_3-	21.7 mmol/L
Sodium	141 mEq/L	SO_2	100 %
Potassium	3.6 mmol/L	TCO_2	22.7 mmol/L
pH	7.44		

in the operating room, then the patient is admitted to the ICU for one day, then the second day patient were transferred to the ward. Patient entered the ICU at 06.00 pm, the first day after surgery in the ICU patient was in a fully conscious condition, GCS E4V5M6, patient was given oxygen face mask of 6 liters per minute with stable hemodynamic conditions. While in the ICU, patient received analgetic regiments such as fentanyl titration 400 mcg for 24 hours and intravenous paracetamol 1 gram every 8 hours. Other ICU therapies included ceftriaxone 2 mg every 24 hours, omeprazole 40 mg every 12 hours, dexamethasone 10 mg every 8 hours, phenytoin 100 mg every 8 hours, mannitol 100 ml every 4 hours. By the second day in the ICU, the patient was breathing independently with the support of a nasal cannula, remained hemodynamically stable, and exhibited a neurological status within normal limits. Subsequently, the patient was transferred to the ward. Below are the results of the patient's postoperative laboratory examination.

DISCUSSION

Sphenoid wing meningiomas are classified as either globoid tumors with a nodular shape or an en plaque tumor, which is flat and spreads along the entire sphenoid ridge. The globoid tumors include three groups depends on their location: inner (medial), middle, and lateral (pterional). Medial sphenoid wing meningiomas have a higher morbidity, mortality and recurrence rate compared to other meningiomas due to their involvement with anterior visual pathways, anterior intracranial arteries, and the cavernous sinus.[1]

Medial sphenoid wing meningiomas are presumed to represent 10% of all supratentorial meningiomas. The principal aim of surgical management is maximal resection with minimal resulting neurological deficits, but complete and safe resection is still a major neurosurgical challenge. Patients with medial sphenoid wing meningiomas frequently present with minimal functional impairment, for which surgery or other therapies can be the best aim to preserve, as well as return to work and preoperative level of activity. High mortality, permanent neurological deficits and incidence of poor outcomes after surgery have forced many neurosurgeons into favoring subtotal or partial resection with adjuvant radiotherapy.[2]

Meningioma is an extra-axial tumor that classified by The World Health Organization (WHO) into three groups based on source, degree of anaplasia and tumor location. The general classification of meningioma based on the WHO criteria as shown in Table 3.

Neuroanesthesia concepts should performed to facilitate the surgery to control intracranial pressure (ICP) and brain volume, protect nerve tissue from injury and ischemia by implementing brain protection techniques, and reduce bleeding during the operation. Several essential things must avoid during surgery such as hypoxemia, hypercapnia, anemia, and hypotension because they will affect the intracranial pressure (ICP), harmful to the central nervous system and surgery results.[4]

A perioperative lumbar CSF drainage maybe useful for resection of sphenoid wing meningiomas. The location of these sphenoid wing meningioma tumors that are sometimes

difficult to access, especially if they are tucked well beneath the frontal and temporal lobes, the combined use of aggressive hyperosmolar and hyperventilation therapy for sphenoid wing removal may remain inaccessible. The difficulty in accessing these lesions can be reduced by using lumbar CSF drainage. Vetsa *et al*. have developed the criteria for perioperative lumbar CSF drainage for sphenoid wing meningiomas with one or more of the following criteria: (1) medial location along the sphenoid wing, (2) vascular encasement resulting in obliteration of the optic carotid cistern and/or proximal sylvian fissure, and/or (3) the presence of associated edema.[5] In this case the tumor was located in the right sphenoid followed with perifocal edema, urging the brainstem and midline shift to the left as far as 0.6 cm and urging the chiasma opticum and extending to the cavernous sinus of the right optic tract, thus in this case it can fulfill the criteria for performing lumbar CSF drainage. Because the risk of causing acute brain herniation, lumbar CSF drainage should be used carefully and only when the dura is open. The patient should receive at least mild hyperventilation when CSF is drained. Normally removal of 10–20 mL of CSF is effective in reducing brain tension, but can be done up to 50 mL drained if necessary.[4]

Neoplasm in central nervous system can cause increased in ICP so the patients may experience headache, nausea and vomiting, ataxia, syncope, and visual and cognitive impairments. In this case, patients had symptoms of worsening headache, nausea, vomiting and tonic-clonic seizures that happened one day before surgery. Managing the proper neuroanesthesia in this case is highly required, main purpose of anesthesia in this case is not only to facilitate surgery but also to control ICP and brain volume, prevent secondary brain injury, and reduce the occurrence of bleeding during surgery. There are three intracranial components include brain tissue, blood, and cerebrospinal fluid. The volume composition of these three components can change according to Monroe Kellie's law, but the total volume is always constant because the intracranial volume is always the same, a volume decrease of one component will follow a volume increase in another component. This condition can occur when the MAP is maintained between 50 and 150 mmHg, target PaO_2 of 100–200 mmHg and $PaCO_2$ is maintained between 25 and 30 mmHg is required for managing brain tumor, to decrease CBF because CO_2 is a potent vasodilator in brain blood vessels.[4,6]

In this case, patient also maintenance at a normothermia condition using a blanket warmer to keep the body temperature at 36.5–37.5 °C. Normothermia should be a major goal of neuroanesthetic management, because hypothermia can impairs platelet function and the coagulation cascade, even mild hypothermia (<1 °C) may increase blood loss and the risk for transfusion. Also other complications of hypothermia are surgical wound infection, adverse myocardial outcomes, prolonged recovery, and shivering.[4]

The anesthesia management from induction and maintenance of anesthesia in this case, we used total intravenous anesthesia. Induction and maintenance of anesthesia we are using propofol with target controlled infusion (TCI) pump mode, opioid fentanyl for analgetic combined with dexmedetomidine, and rocuronium for muscle relaxant. Although there has been controversy surrounding the use of intravenous versus volatile anesthetics for intracranial procedures, however volatile anesthetics are far from ideal agents for neuroanesthesia because of their ability to increase CBF, ICP, and brain bulk. The intravenous agents offer good control of CBF, ICP, and brain bulk, but there are side effect of prolonged or unpredictable awakening remains the main concern with intravenous techniques, but this problem can be mitigated by the use of computer controlled infusion schemes (TCI pumps) and the availability of short acting drugs such as propofol. Propofol produces dose related decreases in global CBF by 50–60%. In PET studies, variation of rCBF reduction has been demonstrated; large decreases occurred preferentially in the medial thalamus, cuneus and precuneus, and posterior cingulate, orbitofrontal, and right angular gyri, which are implicated in the regulation of arousal, performance of associative functions, and autonomic control and also in patients with cerebral tumors with midline shift less than 10 mm, ICP was reported to be lower and CPP higher in patients anesthetized with propofol

than in those anesthetized with isoflurane or sevoflurane.[4,7]

In this case, 50 mg rocuronium IV was given to a patient. Muscle relaxants are known to increase CBF, but the agents that increase CBF the least are vecuronium and rocuronium, so they are the drugs of choice for neurosurgical surgery. Rocuronium was chosen in this case because it is the competitive muscle relaxant that has the fastest onset of action, reportedly reacting within 2 min with an intermediate duration of action, have minimal cardiovascular effects at high doses it has a mild vagolytic effect.[3,4]

Fentanyl 150 mcg IV combine with lidocaine 1-1.5 mg/kgBB, in this case is 60 mg IV was given before laryngoscopic intubation to prevent the increased hemodynamic response and airway response to intubation. The chosen of fentanyl as a postoperative analgesic agent is also given continuously. The effects of synthetic opioids on CBF, $CMRO_2$ and ICP are variable. When vasodilating drugs are used as the background anesthetic, the effect of the opioid is consistently a cerebral vasoconstrictor. Conversely, when a vasoconstrictor is used as the background anesthetic or when no anesthetic is given, opioids either have no effect or even increase CBF. Large doses of opioids decrease CBF in the absence of background anesthetics and also cerebrovascular autoregulation and CO_2 reactivity is preserved with opioids. A Positron Emission Tomography (PET) study in awake humans showed that fentanyl (1.5 µg/kg) showed heterogeneous changes in rCBF, increased in the anterior cingulate and contralateral motor cortex and decreased bilaterally in the thalamus and posterior cingulate. Propofol or thiopental given as an induction and an opioid, together with gentle hyperventilation, administered before intubation helps prevent untoward increases in ICP and decreases brain perfusion pressure.[4,7]

Postoperatively patient admitted to the intensive care unit (ICU), in this case patient was manage by early emergence. For early emergence, the patient should preserve of normal oxygenation, temperature, intravascular volume, blood pressure, cardiovascular function, and CNS metabolism. Analgesic strategies should give in ICU, include regular paracetamol and opioids to provide sufficient analgesia. Nonsteroidal anti-inflammatory drugs (NSAID) are rarely used because they inhibit platelet aggregation and patients frequently receive corticosteroids. However, the risk of bleeding due to NSAID is probably very low and has not been demonstrated after neurosurgery. Regular observation for focal neurological deficits or changes in GCS and pupillary responses is fundamental to the early detection of complications and should occur regardless of postoperative destination.[4,6]

CONCLUSION

Optimal post operative conditions for supratentorial tumor surgery are a challenge for anesthetists. This can be achieved by various neuroanesthetic approaches including patient positioning, optimal neuroanesthetic management and technique so that oedema and bleeding can be minimized. Various drugs are available for general anesthesia management; therefore the anesthetist must have knowledge of the effects of each drug, so that the patient's hemodynamic conditions are maintained in addition to achieving slack brain tissue conditions.

CONFLICT OF INTEREST

Authors declare no conflict of interest in the writing of this article.

REFERENCES

1. Nakamura M, Roser F, Jacobs C, Vorkapic P, Samii M. Medial sphenoid wing meningiomas: clinical outcome and recurrence rate. Neurosurgery. 2006 Apr;58(4):626-39, discussion 626-39. doi: 10.1227/01.NEU.0000197104.78684.
2. Zhang J, Shrestha R, Cai BW, Zhou PZ, Li YP, Jiang S. Management of large medial sphenoid wing meningiomas: a series of 178 cases. Turk Neurosurg. 2014;24(5):664-71. doi: 10.5137/1019-5149.JTN.7668-13.2.
3. Kulsum K, Suryadi T. Neuro-anesthetic management of craniotomy-surgery in removal tumor multiple meningioma patients: A case report. Open Access Maced J Med Sci. 2021;9(C):146–50. doi: 10.3889/oamjms.2021.6371.

4. Bruder NJ, Ravussin P, Schoettker P. Supratentorial Masses : Anesthetic Conciderations. In: Cottrell and Patel's Neuroanesthesia. 6th ed. 2016.
5. Vetsa S, Nadar A, Vasandani S, Gorelick E, Bungard J, Barak T, et al. Criteria for Cerebrospinal Fluid Diversion in Retractorless Sphenoid Wing Meningioma Surgery: A Technical Report. J Neurol Surg Rep. 2022 Sep 2;83(3):e100-4. doi: 10.1055/s-0042-1753518.
6. Keown T, Bhangu S, Solanki S. Anaesthesia for Craniotomy and Brain Tumour Resection. Anesth Tutor Week. 2022;(January):1–7.
7. Matsumoto M, Sakabe T. Effects of Anesthetic Agents and Other Drugs on Cerebral Blood Flow, Metabolism and Intracranial Pressure. In: Cottrell and Patel's Neuroanesthesia. 6th ed. 2016.