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Management of anesthesia in cerebellum cavernous with developmental venous anomaly that causes acute cerebellar bleeding following COVID-19 infection: A case report

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***Abstract*---**Cerebellum cavernous also known as cavernous hemangioma is a vascular malformation of the cerebellum, usually with characteristics that appear on the magnetic resonance image (MRI). Cerebellum cavernous is the third most malformation of the cerebellum after venous anomalies and capillary telangiectasis with an incidence of 0.5% of the General population usually not noticed until a hemorrhagic event occurs. Cavernomas can be seen in conjunction with developmental venous anomaly (DVAs) in 20% (range 20%-40%) cases, in which case they are known as mixed vascular malformations. We describe anaesthetic management in a 28-year-old woman with cerebellum cavern with developmental venous anomaly (DVAs) that causes acute bleeding. Occipital craniectomy for cerebellar tumor resection is performed using neuronavigation under total intravenous anesthesia and scalp block using 0.5% ropivacaine without complications. The surgery lasts for six hours and the cavernomas can be removed completely. The patient was discharged home on the fifth day of postoperative surgery with no neurological deficit.

***Keywords*---**cerebellum cavernous, developmental venous anomaly (DVAs), COVID-19, scalp block, total intravenous anesthesia.

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Introduction

Cavernous malformations are a rare type of cerebral vascular malformation. It is a slow-flow vascular structure that undergoes recurrent bleeding and is characterized by low and high intensity in the magnetic resonance imaging (MRI). With the advancement of non-invasive imaging technology, this type of malformation is more often detected. Intracranial developmental venous anomaly (DVA) is a congenital disorder of venous drainage in which blood flows at a slow speed (Cisneros et al., 2019; Rauschenbach et al., 2021). Since cerebellar cavernous malformations can grow and bleed spontaneously, they have a considerable risk of neurological deficits and functional disorders (Rauschenbach et al., 2021). Complete excision of cavernoma malformations is considered the gold standard of therapy. In many cases complete excision generates a long-term cure with the complete recovery of pre-existing neurological deficits (Sá et al., 2022). But the surgical procedure of the surgery on the cerebellum remains challenging (Rauschenbach et al., 2021). We reported cases of cerebellar cavernous malformations in 28-year-old patients who performed tumor resection using neuronavination as well as a literature review of clinical presentation, radiological features, anesthesia management, and results.

Case Presentation

A 28-year-old woman with no relevant medical and family history came with complaints of headaches felt for 5 days, accompanied by nausea and vomiting, especially after long walks and frequent dizziness when sitting and standing for a long time, no weakness of the limbs, impaired cerebellar function, seizures, or loss of consciousness. These complaints were felt to be progressively aggravating after. The history of the disease was, 2 months earlier, the patient had been treated with COVID-19. From radiological examination, mri of the head obtained a firm border lesion of the irregular edge with a size of +/-1.65x1.3x1.5 cm in the left cerebellum with a picture of caput medusae and adjacent protruding veins that appear hypo to isointense in TIWI, hypo to hyperintense in T2W1, restricted diffusion area in DWI with hemosiderin rims, signal drop in SWI. On magnetic resonance angiography (MRA) examination, it was found that Circulus Willisi appeared patented, did not appear aneurysm or vascular malformation. The above findings are a picture of venous angioma in the left cerebellum hemisphere with a size of +/- 1.65x1.3x1.5 cm with intracerebellar acute bleeding.

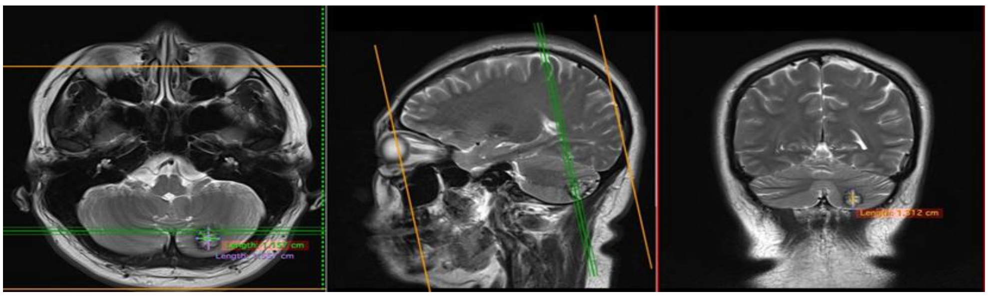

Figure 1. Head MRI with contrast shows a venous angioma in the hemisphere of the left cerebellum with a size of +/- 1.65x1.3x1.5 cm with acute intracerebellar bleeding

No other lesions were found, the patient was diagnosed with cerebellar cavernoma with DVA and acute intraserebelar bleeding and scheduled for occipital craniectomy for mass resection using neuronavigation. Due to the vascular nature of the tumor, blood transfusions informed concent is obtained in advance.

Anesthesia Management

On preoperatif examination, patient’s airway was patent, with adequate thoracic spontaneous breathing 18 times per minute, symmetrical chest movements, right and left vesicular breathing sounds, no additional breathing sounds. Pulse oximetry is 98% with room air (FiO2 21%). A warm, dry and red perfusions are obtained, with a capillary refill time of less than 2 seconds. Blood pressure 123/75 mmHg and MAP 92 mmHg and pulse 87 times per minute with strong radial pulse. GCS score E4V5M6, a round isocor pupil with diameter 3 mm and a positive light reflex. In motoric and cerebellar examinations, no abnormalities are obtained as well as in physiological, pathological and cerebellar reflex examinations.

On routine and clinical chemical examinations revealed haemoglobin 12.7 g / dL, Hematocrit 38.1%, Leukocytes 11,060 / mm3, Platelets 344,000 µL. PPT 11 (controls 9-12), aPTT 20 (controls 23-33). Sodium 146 mEq/L, Potassium 4.1 mEq/L, Chloride 104 mEq/L, randomized blood sugar 96 mg/dL. BUN 11 mg/dL, serum creatinine 0.67 mg/dL, SGOT 14 µ/L, SGPT 25 µ/L, and COVID-19 RT-PCR test showed negative results. From the thoracic photo examination, cor was prominent with a Cardio Thoracic Ratio (CTR) of 50% and the lungs are within normal limits. During preparation for elective surgery, the patient fasted and given an NaCl 0.9% 80 mL / hour IV.

Preoxygenation begins after the placement ASA standards monitoring. Pre-induction vital signs are within normal limits. Induction is carried out by administration of fentanyl (1 µg / kg), propofol (2 mg / kg), and Rocuronium (0.6 mg / kg). Intubation is performed by direct laryngoscopy. After endotracheal intubation, an arterial line installation is placed on the left radial arteri, followed by an analysis of a blood sample (basic arterial blood gas). During surgery, anesthesia is maintain using target-controlled infusion (TCI) propofol and continuous infusion of Dexmedetomidine (0.3-0.7 µg /kg BB/min), rocuronium (0.6 mg / kg / h) and fentanyl (1 µg / kg / h). The administration of dexmedetomidine in this case is so that it can be a sparring agent against propofol so that the dose of propofol is not too large which can have an effect on the patient's hemodynamic condition, besides that the administration of dexmedetomidine in this patient is continued until post-surgery in the ICU.

The installation of mayfield headrest was carried out after scalp block using 0.5% ropivacaine (total 22 ml). The patient is positioned prone with maximum head flexion (concord position) with the observance of airway compression or suppression of the neck veins. The occipital kraniectomy went smoothly and the cerebellar mass was successfully lifted entirely. After the bleeding control is carried out, the dura is closed and sutured layer by layer. Mannitol administered (0.5 mg / kg) in 10 minutes intravenously. During the surgery which lasted for approximately six hours the patient received Ringerfundin 1,200 mL, gelofusin

500ml with an estimated bleeding of 600 mL, urine production during surgery 1,000 mL. hemodynamic conditions during surgery, blood pressure ranges from 100-130/60-90 mmHg with a MAP of 75-90 mmHg, pulses ranging from 90-110 times per minute and pulse oximetry 100%.

The patient is extubated at the end of the procedure, for the post pain control is given injections of Parecoxib Sodium 40 mg / 12 hours, Paracetamol 1 gr / 8 hours, anti-emetic using Ondansetron 4 mg / 12 hours and Omeprazole 40 mg / 12 hours. Next, the patient is transferred to the ICU for the next 24 hours. After that, the patient is transferred to the usual treatment room and discharged home on the fifth day postoperatively.

Figure 2. The patient's position during surgery

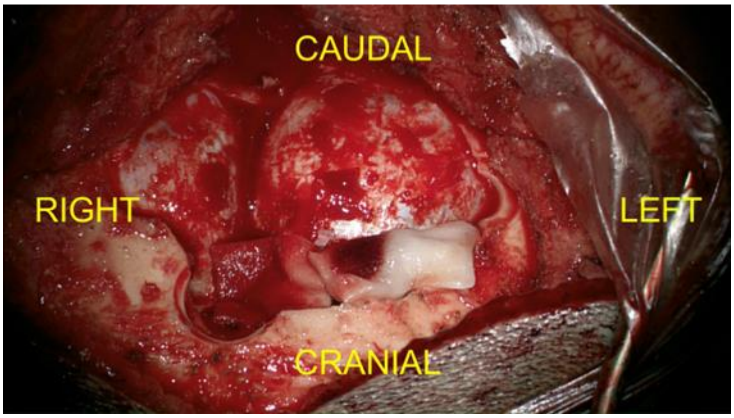

Figure 3. Cerebellum

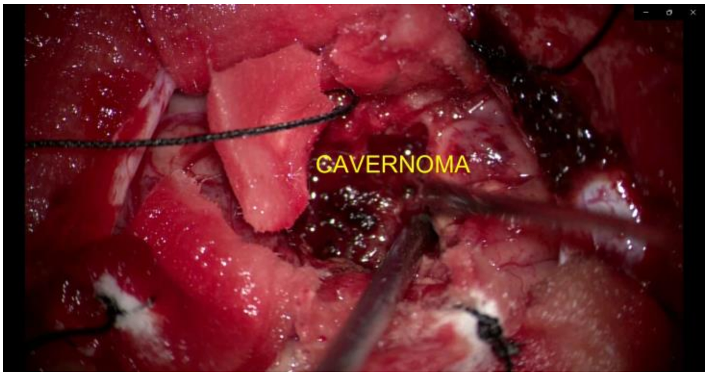

Figure 4. Cavernoma

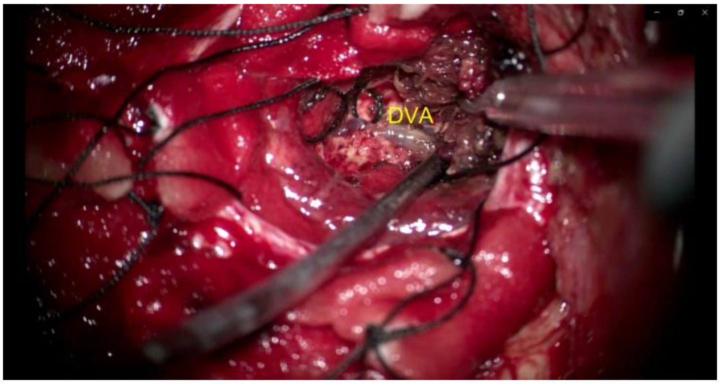

Figure 5. DVA

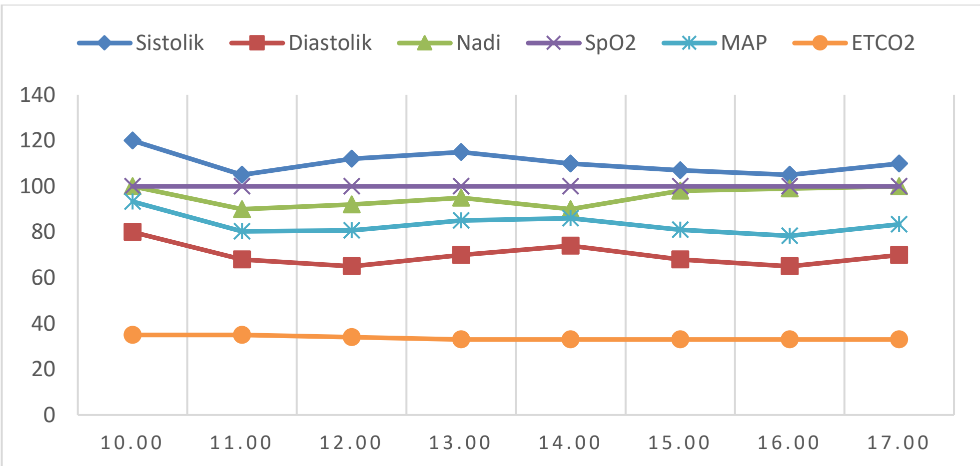

Figure 6. The patient's hemodynamic condition begins to induce, during surgery until arriving in the ICU

Discussion

Results should be clear and concise. Discussion should explore the significance of A 28-year-old woman weighing 72 kg, with no prior history of the disease complained of severe headaches that were felt to be aggravating for 5 days, which was later discovered to be caused by left cerebellum cavernoma then excision of the cavernous with a concorde position and neuronavigation was performed. During surgery, anesthesia maintained with target-controlled infusion (TCI).

Cerebral venous malformations (cavernous hemangioma) are low-flow hemorrhagic vascular lesions of the central nervous system, affecting 0.16% to 0.5% of the population (Chohan et al., 2019). Cavernous malformations can be congenital or acquired vascular abnormalities. Cavernoma can be seen simultaneously with developmental venous anomaly (DVA) in 20% (range 20% - 40%) cases, in this case they are known as mixed vascular malformations (Marzouk et al., 2021).

Anatomically, they consist of abnormal cystic vascular bundles lined by endothelial cell monolayers with disturbed tight-junctions. These blood vessels usually line up as a dense mass that does not interfere with the parenchyma of the brain, so hereditary vascular malformations are hidden blood vessels. They may appear as acute intracranial hemorrhage, mild subclinical hemorrhage, or delayed extravasation of red blood cells, resulting in hemosiderin edges typical of magnetic resonance imaging. In addition to strokes due to bleeding, cerebral venous malformations can cause seizures, headaches, and focal neurological deficits (FND) (Chohan et al., 2019).

Epidemiology of cerebral cavernous malformations consists of 5-13% of vascular malformations of the central nervous system, and develops in 0.02-0.16% of the population (based on serial large autopsies and MRIs). 48-86% are supratentorial, 4-35% of the brainstem, 5-10% of the basal ganglia. Overall, the estimated risk of cavernous malformation bleeding is 0.7% to 6% per year, according to various risk factors, such as previous cavernous malformation hemorrhages, family history, causative genes and infratentorial location, while age, gender, size, multiplicity, and related developmental vein anomalies are not risk factors for cerebral malformation hemorrhage.

MRI plays a key role in the identification and diagnosis of cavernous malformations. More than 40% of all cavernous malformations are found by chance in an MRI. Cavernous malformations can be suspected in the case of large hemorrhagic brain masses, with a 'blood bubble' multi-cystic appearance, surrounded by hemosiderin rings (Sá et al., 2022). Whereas DVA usually clearly visible on CT angiograms, with the main venous collector of DVA appearing as a linear or arcuate enhancement with some branches, giving rise to the classic appearance of "caput medusae" or "palm tree". This anomaly will usually begin in white matter and connect to venous, deep vein or cortical sinuses (Marzouk et al., 2021).

The selection of an ideal surgical approach adapting to their anatomical location is a prerequisite for a good prognosis. Injury to the structure of the brainstem around the lesion can cause surgery-related morbidity, and therefore, proper surgical techniques are essential in cases like this. In recent years, there have been great advances in modern surgical methods and imaging, including intraoperative navigation and electrophysiological monitoring, and these advances have further improved the surgical results of brainstem cavernous malformations (Arslan et al., 2020). Accurate marking has always been a challenge for neurosurgeons during intraparenchymal tumor surgery due to the "brain shift" effect. The use of neuronavigation addresses this problem by allowing intraoperative 3D neuroanatomy navigation. In the study conducted by Pankaj Raj Nepal et all, to evaluate the difference in the percentage of tumor surface marking by experienced neurosurgeons compared to neuronavigation guidelines, there was a difference ranging from 15% to 81% and the average difference was 44%. Where even in the hands of experienced neurosurgeons, marking is not always accurate and neuronavigrating becomes an effective tool (Arslan et al., 2020; Ghimire et al., 2021). The proper surgical technique not only resections the lesion but also minimizes surgery-related morbidity and determines the patient's prognosis after resection.

Coronavirus 19 (COVID-19) is considered a multisystem disease (Afifah et al., 2022; Nidom et al., 2022; Korompoki et al., 2022). Despite respiratory complications, acute cerebrovascular disease (CVD) has been observed in some patients with COVID-19. Li et al. showed that in 4.6% of patients with COVID-19 infection had an acute ischemic stroke and 0.5% of them had intracerebral hemorrhage (Table 1) (Saberi et al., 2022; Salazar et al., 2020). COVID-19-induced coagulopathy is an immunotrombotic state that appears to be more prothrombotic than hemorrhagic (Table 2) (Korompoki et al., 2022; Saberi et al., 2022).

In our patient, the pathophysiology of post-COVID-19 coagulopathy (Figure 7) may have triggered bleeding from cavernoma malformation. Some patients diagnosed with COVID-19 only show neurological symptoms as early symptoms, such as headache, lethargy, unstable walking, malaise, cerebral infarction, cerebral hemorrhage and other neurological signs. In a recent study, 36.4% of patients with COVID-19 had neurological manifestations: The central nervous system (24.8%), the peripheral nervous system (8.9%), and skeletal muscle injuries (10.7%). In patients with manifestations of the central nervous system, the most common symptoms reported are dizziness, headache, impaired consciousness, and acute cerebrovascular disease (Saberi et al., 2022; Salazar et al., 2020).

Endoteliopathy due to direct endothelial infection of SARS-COV-2 and indirect damage caused by lymphocytic infiltration play a major role in the development of COVID-19-related coagulopathy as found in our pathological specimens. Currently, there are many cases of patients with COVID-19 who are complicated by cerebral hemorrhages like ours. Therefore, the physiological link between COVID-19 and the incidence of cerebral hemorrhage associated with thromboangitis pathology is still a rarely reported case.

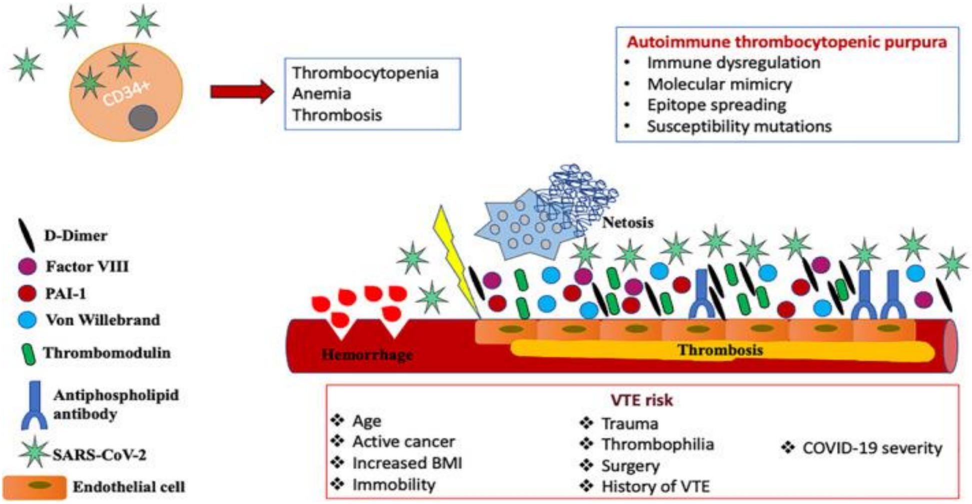

Figure 7. Schematic picture of post-COVID-19 hematological complications

Table 1
Thrombotic events and post-discharge bleeding (Salazar et al., 2020)

Age, y	Sex	Lenghth of hospital stay, d	ICU stay	Postdischarge day event occured	Type	Event details	Anticoagulation received during index hospitalization
Thrombosis							
33	Female	14	Yes	3	PE	Presented with acute shortness of breath and diagnosed with bilateral segmented pulmonary emboli	Enoxaparin: 40 mg once daily
80	Female	3	No	21	Left ventricula thrombus, central retinal artery occlusion	Presented to emergency room with acute unilateral blindness; echocardiogram revealed a ventricular aneurysm with thrombus	Heparin: 5000 U twice daily
51	Female	8	No	25	Thrombosis of arteriovenous dialysis fistula	Chronic dialysis for end-stage renal disease developed thrombus of established brachial fistula used for access	Heparin: 5000 U twice daily
59	Female	11	Yes	40	Ischemic stroke	Presented with vision loss,	Heparin: 5000 U twice daily/

						headache, and neglect and diagnosed with left parieto-occipital infarct	Enoxaparin: 40 mg once daily
Hemorrhage							
78	Male	11	Yes	13	Major hemorrhage	Mechanical fall with femoral fracture, received transfusion due to hematoma	Mechanical fall with femoral fracture, received transfusion due to hematoma
60	Female	9	No	16	CRNMB	Large subcutaneous hematoma over lumbar sacral area following mechanical fall with referral to emergency room	Large subcutaneous hematoma over lumbar sacral area following mechanical fall with referral to emergency room
77	Female	4	No	24	CRNMB	Large subcutaneous hematoma over lumbar sacral area following mechanical fall with referral to emergency room	Heparin: 5000 U twice daily
59	Male	14	No	30	CRNMB	Gross hematuria required catheter placement and urologic evaluation	None
73	Male	6	No	31	Major hemorrhage	Fall with head strike resulted in subarachnoid hemorrhage	Enoxaparin: 40 mg once daily
51	Male	13	No	31	CRNMB	Mechanical fall with scalp hematoma, required emergency management	Enoxaparin: 40 mg once daily

Table 2
Representative studies report thromboembolic/hemorrhagic manifestations of subacute and/or chronic COVID-19 (Korompoki et al., 2022)

Study	Design	Study population	Type of event	Anticoagulation	Time interval between diagnosis and time of event
Patell et al. 18	Retrospective observational	*n* = 163 F: 52.2% Obesity: NR	VTE 2.5% 1 PT 1 ICT 1 thrombosed AV fistula 1 ischemic stroke Hemorrhagic events: 3.7% 2 MB 4 CRNMB	No	Median duration to thrombotic event post discharge 23 days (IQR: 12-33) Median duration to event post discharge: 27 days (IQR 16-31 days)
Roberts et al. 19	Retrospective observational	*n* = 1877 F: NR Obesity: NR	VTE *n* = 9 (11%) 2 proximal DVT 7 PE	No	Median duration to event post discharge 8 days (IQR 3-33 days)
Engelen et al. 20	Prospective cohort study Systematic post-discharge screening	*n* = 102 F: NR Obesity: NR	0 symptomatic events 1 asymptomatic VTE	8% on prophylactic LMWH	Outpatient follow-up screening at 6 weeks post discharge
Bourguignon et al. 21	Retrospective cohort study	*n* = 140 Discharged from medical ward F: 46% Obesity: NR *n* = 35 discharged from rehab ward F: 63% Obesity: NR	0.71% *n* = 1 PE 0%	10% on anticoagulation at discharge 29% on anticoagulation at discharge	Event at 9 days post discharge
Huang et al. 22	Cohort study with systematic screening	*n* = 2469 F: 48% *n* = 390 F: NR Obesity: NR	Three ischemic strokes one PE (only events requiring re-admission reported) No asymptomatic	NR NR	NR NA

			VTE in screening		
Giannis et al. 23	Prospective registry	$n = 4906$ F: 46% Obesity: 18.9%	$n = 76$ (1.55%) VTE DVT 44 PE 42 Splanchnic VT 2 $n = 84$ (1.71%) ATE stroke 22 MI 24 MLE 26	12.7% on thromboprophylaxis $n = 62$ (1.3%) enoxaparin $n = 3$ (0.06%) UFH $n = 180$ (3.7%) apixaban $n = 336$ (6.9%) rivaroxaban	Outcomes at 90 days post discharge
Spyropoulos et al. 24	Case series	$n = 4$ M: 100% Obesity: 0%	Two large-vessel ischemic strokes one acute ischemic limb (emboli from aortic thrombosis) one AL STEMI	No	Median time to event post diagnostic 72 days

Anesthesia Consideration

Different drugs and anesthetic techniques affect intracranial hemodynamics in a variety of ways. The choice of a particular anesthetic agent or technique in the brain tumor surgery depends on the general condition of the patient, comorbidity, an increased level of intracranial pressure. The purpose of anesthesia is primarily to maintain cerebral oxygenation, providing relaxed brain without compromising the pressure of cerebral perfusion. and therefore the impact of the agent on CBF, intracranial pressure, hemodynamic stability and epilepogenic risk should be considered (Cottrell James, E. & Piyush, P., 2017). Surgery on the posterior fossa increases the risk of position-related complications. The challenges of this operation are inseparable both from the general principles of anesthesia and from neuro-anesthesia and neuro-resuscitation including the risk of bleeding, air embolism, hemodynamic instability, management of cerebral blood flow (CBF) or possible intracranial hypertension. It requires careful evaluation, proper anesthesia strategies, and careful monitoring (Cottrell James, E. & Piyush, P., 2017).

Surgery-Related

Bleeding, sometimes massive even with good surgical hemostasis control, the installation of large venous access and the appropriate transfusion strategy should be thought of in the first place.

Anesthesia-Related

The preoperative assessment should look for pre-existing neurological deficits, the stability of epilepsy and in the context of emergencies, the presence of intracranial hypertension, the risk of bleeding (hemoglobin, platelets, coagulation) and electrolytic abnormalities in the case of recurrent. Premedication should be adapted for clinical conditions (Clonidine, Midazolam or Hydroxyzine).

It is well known that cerebral perfusion pressure (CPP) is the average arterial pressure (MAP) minus intracranial pressure (ICP) (CPP = MAP - ICP). In this case it is even more complicated when high pressure is localized in the posterior fossa and the anesthesiologist is responsible for this. Anesthesia plans should take into account pharmacological approaches capable of promoting a reduction in cerebral blood flow with a decrease in intracranial pressure and an increase in cerebral perfusion pressure. In this case with the presence of a picture of intraserebelar acute bleeding, we can estimate that the administration of strong osmotic diuretics such as mannitol 20% (0.5-1 g / kg) will be very meaningful in reducing infratentorial pressure. It will also help the optimization of brainstem perfusion as it reduces the effects of mass and compression (Dos Santos e Santos et al., 2021).

And as the growing popularity for the use of total intravenous anesthesia (TIVA) especially for neurosurgery because it has more advantages than volatile administration against increased cerebral perfusion pressure as a result of a decrease in cerebral blood flow and intracranial pressure ((Dos Santos e Santos et al., 2021; Cole et al., 2007), stimulating the emergence of a new discovery that can calculate and estimate the levels of anesthetic drugs in plasma and target organs that became known as organ target-controlled infusion (TCI) (Schnider et al., 2016).Until no, there are two models for TCI propofol namely the Marsh and Schnider models. It requires knowledge of the concepts of the three compartments of pharmacokinetics and pharmacodynamics in order to use both models properly. When using the Marsh model, it is recommended to use a plasma target, while in Schneider model a target effect is used. If TCI propofol is used properly, it can maintain hemodynamic stability starting from the time of induction, during surgery and recovery time.

The neuroprotective nature of the administration of propofol through continuous intravenous infusion during surgery causes the activation of gamma-aminobutyric acid receptors of type A (GABA) with the opening of chloride channels and neuronal hyperpolarization thereby protecting the central nervous system (CNS) against oxidative stress. This decrease in metabolic needs is strongly associated with reduced cerebral blood flow (CBF) without causing neuronal or glial hypoxic-ischemic. Since it is a short-acting anesthetic agent with antiemetic properties, it is expected that extubation can be performed at the end of case (Dos Santos e Santos et al., 2021; Fan et al., 2015). Antibiotic prophylaxis administration adapted to local ecology (Cefazolin) (Cottrell James, E. & Piyush, P., 2017).

The head pin placement into the periosteum is an acute pain stimulation during intracranial surgery that can result in sudden spikes in blood pressure and heart rate, causing an increase in intracranial pressure (Pang et al., 2022; Arunashree et al., 2019). Scalp block (blockade of nerves that innervate the scalp, including the larger and lower occipital nerves, supraorbital and supratrochlear nerves, auriculotemporal nerves, and larger aurricular nerves) (Figure 7, 8) may be effective in reducing hypertension and tachycardia (Arunashree et al., 2019; Prough et al., 1996). About 10% to 20% of patients undergoing craniotomy suffered from severe pain and more than 30% experienced moderate pain as per Guilfoyle et al (Guilfoyle et al., 2013). This can prolong length of stay in the hospital, a sudden increase in heart rate and blood pressure leads to potential morbidity and mortality due to an increase in intracranial pressure in patients (Tuchinda et al., 2010; Chattopadhyay et al., 2013). Generally, opioids are used to eliminate hemodynamic fluctuations and reduce postoperative pain, however, it can delay recovery time, contribute to long sedation, and interfere with postoperative neurological examinations. In addition, opioid side effects such as nausea and vomiting, and respiratory depression can result in an increase in intracranial pressure. Because there is an emphasis on controlling the side effects of opioid administration, postoperative pain after craniotomy is often uncontrolled. Reducing hemodynamic disorders and relieving postoperative pain is an important issue for neuroanaesesiologists and is also an important component of Enhanced Recovery After Surgery (ERAS) (Yang et al., 2020).

With advances in modern anesthesia came the development of fast-acting analgesics, especially remifentanil can be used instead of opioids to treat postoperative pain (Ayoub et al., 2006), scalp block, which blockades nerves that innervate areas of the scalp involved in surgery (Papangelou et al., 2013), developed due to its potential benefits as an effective regional anesthetic (Pang et al., 2022; Kim et al., 2011). in neurosurgery, such as functional neurosurgery and microsurgery (Yang et al, 2020).

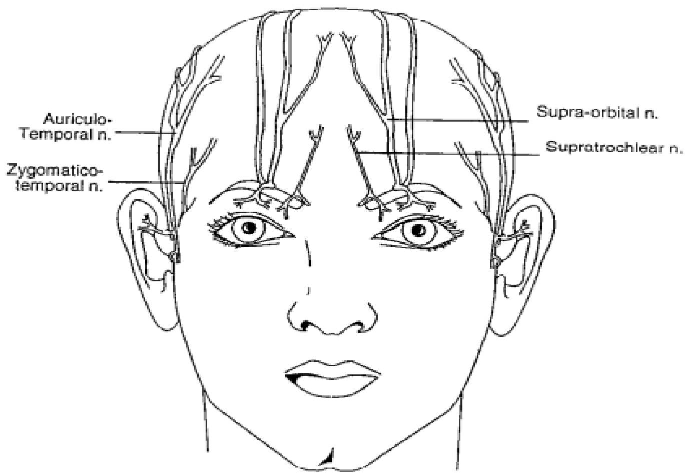

Figure 8. Innervation of the scalp. The terminal branch of the ophthalmic branch of the trigeminal nerve, the supraorbital and supratrochlear nerves. The terminal branch of the division of two trigeminal nerves, the zygomaticotemporal nerve, is illustrated. The terminal branch of the mandibular division of the trigeminal nerve, the auriculotemporal nerve (Prough et al., 1996)

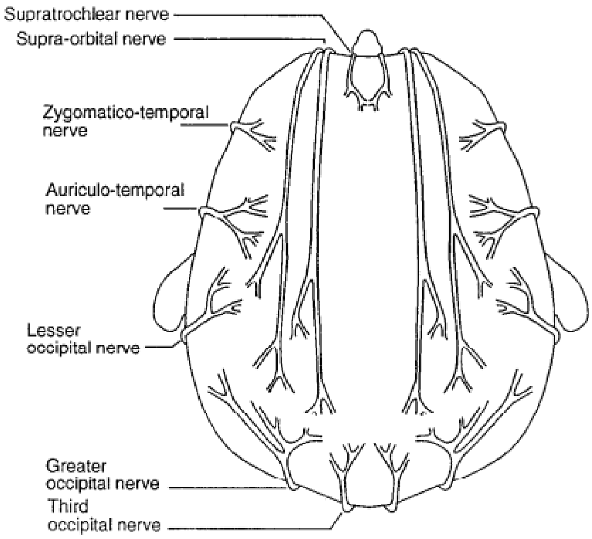

Figure 9. Coronal cut innervation of the scalp. Terminal branches of the ophthalmic branches of the trigeminal nerve, supraorbital and supratrochlear nerves. The terminal branch of the division of two trigeminal nerves, the zygomaticotemporal nerve is illustrated. A terminal branch of the mandibular nerve, the auriculotemporal nerve is also shown (Pang et al., 2022)

Intraoperative

Bleeding is clearly a major concern on this operation. Arterial line is placed on the left radial arteri to early detect any variations in blood pressure. Any variations should be corrected immediately. Hypotension and its impact on cerebral blood vessels; hypertension and its impact on intracranial pressure and bleeding from the site of surgery. Three large venous lines are installed to ensure rapid transfusions. During surgery, the patient is maintained in conditions of normoxia, normokapnea or slight hypocapnia to optimize cerebral blood flow (Dos Santos e Santos et al., 2021). Hypothermia, always feared in anesthesia and can be prevented by the use of a warming blanket.

Table 3
Non Pharmacological Brain Protection (Saberi et al., 2022)

Relaxed brain
Good head position Drainage cerebrospinal fluid Diuretic/osmotherapy Avoid excessive cerebral vasodilation Mild hypocapnea
Controlled Systemic and cerebral Hemodynamics
Euvolemia Optimal cerebral perfusion pressure
Fluid and electrolyte management
Euglycemia

Isotonicity
Temperature management
Postoperative Prevention of hypothermy Toleration of modest hypothermia Intraoperative
Controlled Emergence
Tailored Awakening Autonomic control

Adapted from James E. Cottrell. Cottrell and Patel's Neuroanesthesia sixth edition. Elsevier 2017; Anesthesic Considerations For AVM Resectioan p.268 (Cottrell & Patell, 2017).

Table 4
Face down Position Issues (Matsumoto et al., 2015; Alian, 2015)

Potensial problem	Comments
Eyes	
Corneal Abrasion	Ensure eyes taped shut
Optic Neuropathy	Icreased intraocular pressure leads to decreased perfusion pressure Reduce risk by avoiding compression to the eyes, hypotension, low haematocrit
Retinal artery occlusion	Avoid pressure in the eyes
Head and neck	
Venous and lymphatic obstruction	Careful positioning to minimize venous obstruction
Skull fixation	Insertion of pins into skull can result in a hypertensive response that is difficult to control
Abdominal compression	
Impaired ventilation	Avoid abdominal compression as far as possible
Decreased *cardiac output*	Bean-bag mattress or pillows are output better than supportive frames or knee–chest position
Damage to major vessels	
Aorta or inferior vena cava	Accidental damage following perforation of anterior longitudinal ligament Produces major bleeding into wound, and presents with acute reduction in blood pressure and electro- mechanical dissociation arrest High mortality
Iliac vessels	Less acute presentation. High index of suspicion to avoid delayed diagnosis

Adapted from Matsumoto M, Ishida K. Anesthesia for spinal surgery. Neuroanesthesia Cerebrospinal Prot. Published online 2015:417-428. doi:10.1007/978-4-431-54490-6_36.

PostOperative

Endocrine and electrolytic disorders such as SIADH, cerebral salt wasting syndrome (CSWS) and diabetes insipidus are rare in posterior fossa surgery, diuresis and ion balance will be monitored regularly[1]. Complications of this procedure include post-operative hematomas and edema, CSF leakage, neurological disorders or deficits, or brainstem deficits, multiple, recurrence and tumor residue, as well as infarction of the vertebral artery or posterior cerebellar artery[2]. Neurological monitoring include level of consciousness and neurological deficits. Emergency imaging should be considered immediately in case of impaired consciousness or neurological disorders. Due to the difficulty of surgery with the face down position, and possible complications, the patients is observed in the ICU under close supervision.

Conclusion

In this case a patient with intracranial hemorrhage with cerebellar cavernous and underlying DVA. Cavernous malformations are unusual entities that may coexist with deep vein anomalies, thus making management more challenging. Brain imaging findings and clinical presentations in our patient suggest that cavernoma is the leading cause of hemorrhagic events with underlying DVA. Posterior fossa surgery is an everyday challenge for anesthesiologists, forcing a good knowledge of the peculiarities of neuro-anesthesia. Only with careful handling, careful perioperative monitoring, screening and immediate correction of potentially harmful complications will it be possible to get the best results from this surgery. This requires perfect coordination and communication between the anesthesia and surgical teams.

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