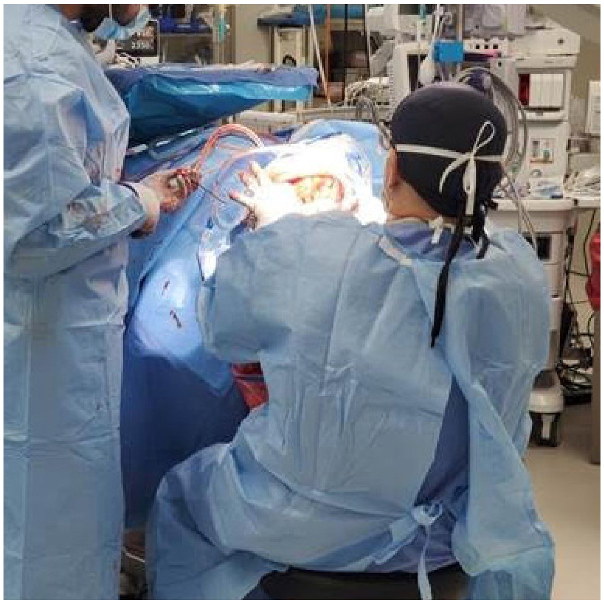
SCIENCE AND TECHNOLOGY

Case Study: Emergent Craniotomy

CHELSEA MOSER
OCCC ANESTHESIA TECHNOLOGY



ABSTRACT

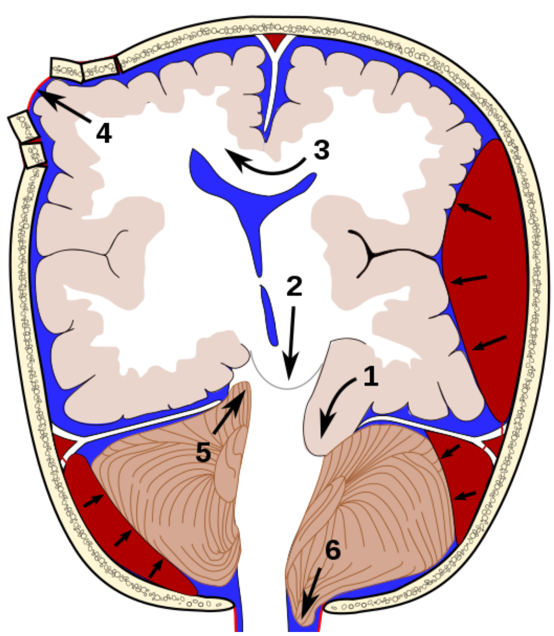
Malignancy is a term that refers to the existence of cancerous cells that can metastasize (spread to other tissues in the body, occupying local tissues and destroying them (MedlinePlus, n.d.). Malignant tumors can develop new internal blood vessels, which can bleed or become occluded, resulting in necrosis and neurologic dysfunction that can mimic stroke. In this case, a 21-year-old male presented to the hospital with chronic headaches, nausea, and vomiting. A cranial CT scan revealed a large tumor in the patient's Brain. The following morning, the patient underwent a craniotomy for a brain tumor. After surgery, the patient remained intubated and was transported to the intensive care unit (ICU). During nursing rounds, the patient's left pupil was blown (fully dilated and unresponsive to light), and the patient was immediately transported to CT to re- evaluate the patient's head. During the CT examination, the patient went into cardiac arrest. The patient was transported to the operating room for an emergency brain tumor resection.

EMERGENT CRANIOTOMY

In this case, the individual is a twenty-one-year-old (21) male suffering from a massive subdural hematoma and undergoing an emergency craniotomy for resection. Upon evaluation of the medical record by the anesthesia care team, he was designated as an ASA status of V. An ASA V classification indicates that without surgical intervention, survival is not expected (ASA, 2020). He was approximately seventy-four (74) inches tall and weighed sixty-four (64) kilograms. The patient's systems review includes a history of severe headaches, nausea, vomiting, hypotension, tachycardia, and leukemia. The patient's airway was also secured in the intensive care unit from the previous surgery that morning.

OVERVIEW OF AN EMERGENCY CRANIOTOMY

Craniotomies for tumor resection are typically performed in relation to their location and etiology. The tumor is either supratentorial, meaning the tumor is located above the tentorium in the cerebrum, or it is infratentorial, which indicates the mass is below the tentorium of the Brain in the cerebellum (Sattar, 2018). Second, the tumor will be either intraaxial, located inside the Brain, or extraaxial, located outside of the Brain (Tatco, 2022). For this procedure, the mass was a supratentorial intraaxial tumor requiring the removal of the cranium to access the tumor and the removal of brain matter to excise the mass (Jaffe, 2020). The likely etiology was a primary glioblastoma based on the location of the mass and the patient's age. Glioblastomas are tumors whose origin begins in the brain tissue. These are considered the most aggressive tumors for their growth rate and location in the Brain (Bleeker, 2012). According to Tan et al. (2020), Glioblastomas are most often characterized by location within the astrocyte, a type of glial cell in the Brain. Additionally, these tumors are further characterized by their "proliferation" into the vascular anatomy of the Brain (Tan et al., p. 300, 2020). This is important as this proliferation into the vascular structures can cause increased blood loss, resulting in a hematoma.



Although rare, hemorrhage is one major complication of removing a large glioblastoma via craniotomy (Jaffe, 2020). Post-operative hemorrhage accounts for between 0.8% and 1.1% of all craniotomies performed; however, the mortality rate of patients who hemorrhage is 32% (Barker, 2008). The main reason for this increased mortality rate is the speed at which the hematoma develops, which warrants emergency surgery to decompress the Brain to restore perfusion and lower ICP (Barker, 2008). For this case report, the focus will not be on the removal of the glioblastoma but on the secondary surgery to respond to the subdermal hematoma that developed post-operatively.

In emergency situations requiring a response to a subdermal hematoma, the main focus of the surgical team is to alleviate pressure on the Brain and correct bleeding (Jaffe, 2020). Patients needing decompression will have elevated intracranial pressures (ICP), which is a value above 20mmHg. ICPs above 20mmHg cause a reduction in blood flow throughout the Brain and cerebral spinal fluid purging from the subarachnoid space (Farkas, 2022). For this reason, the anesthesia team utilizes pharmacological agents that reduce ICP and optimize "surgical exposure and minimize retractor-related edema" while the surgical team performs the intervention (Barash, p.1017, 2017).

PHARMACOLOGY SPECIFIC FOR PATIENTS WITH INCREASED ICP

The anesthesia care team will use several medications and interventions to lower ICP for patients needing surgical intervention of a subdermal hematoma. Mannitol is given as a bolus to rapidly achieve its effect (Barash, 2017). Mannitol is a diuretic used most often to treat acute renal failure, increased intraocular pressure, and cerebral edema (Barash, 2017; Roach, 2005).

Mannitol is referred to as an osmotic diuretic, as it promotes fluid movement from the "intracellular spaces into extracellular spaces" (Pardo & Miller, 2018). The intracellular to extracellular fluid movement makes it ideal for intraoperative treatment of subdermal hematoma as it directly reduces brain size via this movement of fluid out of the cell (Pardo & Miller, 2018). While mannitol is an effective diuretic in reducing brain volume, it is recommended that furosemide be given concurrently with mannitol. One major factor indicating this concurrent use of furosemide with

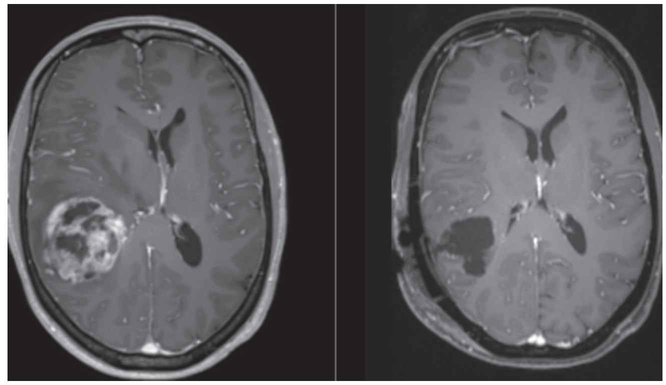
mannitol is the resulting increase in cerebral blood volume and transient increases in ICP associated with the initial fluid movement caused by mannitol (Jaffe, 2020). The furosemide removes excess fluid by preventing sodium reabsorption, which occurs at the loop of Henle (Pardo & Miller, 2018; Jaffe, 2020).

Another medication used to reduce ICP in states of subdermal hematoma is the infusion of hypertonic saline solutions. Barash (2017) indicates that the ideal starting concentration is a 3% solution administered continuously at 50-100mL per hour (Barash, 2017). However, Jaffe (2020) indicates that a 7.5% concentration can replace mannitol (Jaffe, 2020). It is understood that the use of hypertonic solutions creates an "osmotic gradient," similar to mannitol producing fluid movement from an area of high pressure to an area of low pressure (Suarez, p.10, 2004).

Additionally, hypertonic solutions decrease blood viscosity, which correlates to an increase in cerebral vasoconstriction. The resulting factor is an increase in cerebral blood flow during these periods of increased ICP (Suarez, 2004). It is important to note that the technologist and anesthesia care team should regularly evaluate sodium levels with arterial blood gases to look for hypernatremia or hyponatremia (Barash, 2017).

SURGICAL APPROACH EVENTS

The planned surgical intervention was a craniotomy for resection of a subdural hematoma. The planned modality of anesthesia was general anesthesia, a medically induced loss of consciousness that renders the patient unarousable with a



combination of intravenous medications and inhaled gases. The decision to utilize general anesthesia was made because the proposed surgery required the patient to be paralyzed, meaning that the patient's muscles would not elicit a response to surgical stimulation. Before the patient entered the operating room, the technologist and anesthesiologist discussed placing an arterial line and a central line. An arterial line is a catheter placed into the radial artery to display a patient's blood pressure continuously. The arterial line also allows the provider to sample the patient's blood without having to draw blood continuously from a different vessel. A central line is a large bore catheter typically placed within a patient's internal jugular vein. The purpose of the central line is to give medications, fluids, monitor a patients CVP, and can be used to draw blood. However, when the patient entered the operating room, he already had a radial arterial line and a left internal jugular central line. Once the patient was moved onto the operating room table, the technologist placed standard ASA monitors onto the patient, a lower body Bair-hugger to keep the patient's temperature normal, and connected the arterial line to its corresponding monitors.

During the surgical procedure, the patient was maintained by TIVA (total intravenous anesthesia) general anesthesia with low doses of Propofol (which puts the patient to sleep), Rocuronium (which acts as a paralytic to stop any form of muscle reactivity to surgery), and low doses of Sevoflurane (which also is an aid to put the patient to sleep). Once the surgeon began operating on the patient, the patient showed signs of Cushing's Triad. Cushing's triad is a physiological nervous system response to acute elevations of intracranial pressure (ICP) (Dinallo & Waseem, 2021). This presents as a widened pulse pressure (increased systolic and decreased diastolic), bradycardia (slow heartbeat), and irregular respirations (slow and shallow breathing).

The Cushing reaction acts as a "domino effect." Cerebrospinal fluid pressure increases and intracranial tension grows.

As the pressure grows, it causes compression of the Brain and surrounding arteries, cutting off the blood supply to the Brain. The Cushing Triad is; unfortunately, a delayed indication of increasing ICP and evocative that brainstem herniation is forthcoming. During the procedure, the surgeon discussed transferring the patient back to CT to determine the status of the patient's condition but decided against transporting the patient due to the risk of losing the patient on transportation. The surgeon also decided to stop surgery overall. He explained that continuing the surgery would be ineffective for the patient's overall condition. After the surgeon finished closing, the patient was transferred back to the intensive care unit, where ICU staff would continue monitoring him. Several hours later, the patient would pass from the subdermal hematoma.

CONCLUSION

Glioblastomas are primary brain tumors and can present additional complications post- surgical removal. In the case of this surgery, the patient developed a subdermal hematoma, which required emergency surgery to correct. However, as the literature indicates, the mortality rate from these cases remains high at 32%. For the anesthesia technologist, there are several areas of concentration for future exposures to patients presenting for tumor resection. One is a recognition that despite hemorrhagic complications being rare, occurring in 0.8% to 1.1% of all cases performed, emergency surgical intervention is required in events of hematoma. Two, managing patients needing decompression of a subdermal hematoma is complex and requires advanced hemodynamic monitoring, including arterial blood pressure monitoring, central venous pressure monitoring, and, most crucially, intracranial pressure monitoring. Third, the technologist should be cognizant of the patient's pharmacological needs, including diuretics, mannitol and furosemide, and hypertonic solutions to reduce fluid in the Brain, increase cerebral blood flow, and lower ICP. Finally, technologists should be vigilant and stay in the operating room during these procedures to respond to adverse events such as seizures and cardiac arrest.

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Continuing Education Quiz

To test your knowledge on this issue's article, provide correct answers to the following questions on the form below. Follow the instructions carefully.

1. What is the main focus of an emergency craniotomy for a subdermal hematoma?
A) Restoring blood flow
B) Alleviating pressure on the Brain
C) Preventing tumor growth
D) Correcting bleeding

2. Which anatomical term describes a tumor located above the tentorium in the cerebrum?
A) Supratentorial
B) Infratentorial
C) Intraaxial
D) Extraaxial

3. What is the likely etiology of the tumor in this case?
A) Metastatic cancer
B) Primary glioblastoma
C) Meningioma
D) Hemangioma

4. Which type of cells are most often associated with glioblastomas?
A) Neurons
B) Astrocytes
C) Erythrocytes
D) Oligodendrocytes

5. When treating a Subdermal hematoma, the goal is to keep the ICP ___________.
A) Above 20 mmHg
B) Below 10 mmHg
C) Exactly 20 mmHg
D) Below 20 mmHg

6. Which medication is given concurrently with mannitol to prevent transient increases in ICP?
A) Furosemide
B) Hypertonic saline
C) Propofol
D) Rocuronium

7. What is the purpose of an arterial line in this context?
A) To monitor blood pressure continuously
B) To administer medications
C) To measure intracranial pressure
D) To administer hypertonic solutions

8. What is the Cushing Triad indicative of?
A) Decreased intracranial pressure
B) Improved cerebral blood flow
C) Brainstem herniation
D) Surgical success

9. What is the main purpose of hypertonic saline solutions in this context?
A) To induce sleep
B) To rehydrate the brain
C) To increase cerebral blood flow
D) To promote fluid movement into cells

10. What are the main pharmacological agents used to lower ICP in this case?
A) Antibiotics and antifungals
B) Painkillers and sedatives
C) Mannitol, furosemide, and hypertonic saline
D) Chemotherapy drugs

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2. A B C D	6. A B C D	10. A B C D
3. A B C D	7. A B C D	
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