

ANESTHESIA MANAGEMENT OF PATIENTS WITH REDO CRANIOTOMY: CASES OF SUPRATENTORIAL RECIDIVE TUMORS

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ABSTRACT

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Background: Compared to non-surgical therapies, redo craniotomy is linked to improved neurological state and a lower mortality rate. But it also carries a higher price tag and complication risk.

Aim: The researchers would like to discover anesthesia management of patients with redo craniotomy in patients with supratentorial recidive tumors.

Method: The researchers used the case study method. Two cases of redo craniotomy performed at the Santosa Hospital Bandung Central Indonesia are presented. The first case involved a 24-year-old male with a supraorbital tumor, GCS 15, and the second case involved a 43-year-old woman with meningiomas, GCS 15. The first patient underwent redo craniotomy six (6) months after the first operation, while the second patient underwent the procedure three (3) months after the first operation. These patients were subjected to anesthesia using the same techniques and anesthetic drugs. patients were positioned in a neutral position with 20-30 degree head up, voluntary hyperventilated, and adequate anxiolytics.

Findings: The bleeding volume of the patients was 800 mL for the first patient and 1,000 mL for the second, and the fluid balance was maintained using the ringerfundin balance solution. The durations of the operation of the first and second patients were 4 and 6.5 hours, respectively. Postoperatively, patients were treated in the ICU for one day under mechanical ventilation and were transferred to the ward after extubation. Better intraoperative care, improved surgical skills, surgical equipment, and better intensive care support are likely to improve outcomes in patients with redo craniotomy.

KEYWORDS

case study, brain tumor, redo, craniotomy



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INTRODUCTION

The rate of reoperation is defined as the percentage of patients who return to the operating room (OR) within 30 days of the initial craniotomy and undergo a recurrent craniotomy procedure (redo). This is one the the key factors of in the quality of care assessment and has implications for outcomes, especially in the case of oncological surgeries. Redo craniotomy is associated with improved neurological status and decreased mortality rate compared to non-surgical interventions, but is associated with higher costs and risk of complications (Raghib et al., 2022). Hypertension, anticoagulation, and antiplatelet therapy are common risk factors for repeating craniotomy within 30 days. Patients with this condition need a special care to prevent

returning to the operating room. They also need to be monitored for bleeding in the short term (one to two days) and hydrocephalus in the long term (2 to 30 days) and treated early when necessary (Raghib et al., 2022). Surgical outcomes and the rate of complications are some of the most important factors to consider when choosing a surgical approach over others.

Neurosurgery, one of the more complex surgical disciplines, has higher overall morbidity and mortality rates than a lot of other surgical fields (Dasenbrock et al., 2017). Neurosurgeons seek to cure patients from intracranial tumors with a single operation, thereby eliminating the need for further interventions. Unfortunately, additional procedures are often required, largely due to the incomplete resection during the primary surgery and relapses.

The question of whether to re-operate or not can be challenging, and various factors, including the patient's clinical state and cancer prognosis, must be considered. In general, it is very important for therapeutic decision-making and informed consent to have a strong estimate of the benefits and risks of the treatment provided. This is especially true in situations where therapeutic alternatives to surgery may be offered, such as radiotherapy and/or chemotherapy. In the daily treatment of clinical patients, we have experienced the beneficial and unfavorable effects of repeated surgery for intracranial tumors. Repeated interventions are sometimes considered more difficult, since the anatomical structures have been manipulated and scarring and adhesions can interfere with surgery. In addition, dural closure and wound healing may be more difficult and the infection rate is higher. For this reason, previous reports have shown higher rates of morbidity and complications for surgical redo (Zattra et al., 2019).

The first large prospective comparative cohort study of recurrent glioblastoma multiforme (rGBM) showed that recurrent resection provides small but significant benefits in survival and quality of life compared to non-operative treatments. The best prognosis is associated with a younger age, a Karnofsky Performance Status (KPS) of ≥ 80 , late recurrence, methylation of methylguanine methyltransferase (MGMT) promoters, and extent of resection (EOR) > 80 (Mukherjee et al., 2020).

The problem in redo craniotomy depends on the timing of the repeat operation is performed. The cut-off is determined as 21 days. If the repeat operation is performed in less than 21 days from the initial operation, there may be a risk for pneumocephalus complications; however, if the operation is performed after 21 days, bleeding may occur due to the possibility of established tissue adhesion (Bisri & Bisri, 2016). In a prior study by Chen et al. (2016), glioblastoma patients had improved 10-year survival rates following re-craniotomy. Despite this, there is no set time restriction on how often they can repeat the craniotomy.

Based on the background, the researchers attempted to discover anesthesia management of patients with redo craniotomy in patients with supratentorial recidive tumors. In the two case reports presented in this paper, the first patient underwent a redo surgery after 6 months of the first operation, while the second patient received the redo surgery 3 months after the first operation. Both patients were operated on and treated at the Santosa Hospital Bandung Central Indonesia.

METHOD

The research is descriptive qualitative research with the case study method to discover the anesthesia management of patients with redo craniotomy in patients with supratentorial

recidive tumors. The source of data in this study was the observation conducted by the researchers.

Two cases of redo craniotomy performed at the Santosa Hospital Bandung Central Indonesia are presented. The first case involved a 24-year-old male with a supraorbital tumor, GCS 15, and the second case involved a 43-year-old woman with meningiomas, GCS 15. The first patient underwent redo craniotomy six (6) months after the first operation, while the second patient underwent the procedure three (3) months after the first operation. These patients were subjected to anesthesia using the same techniques and anesthetic drugs. patients were positioned in a neutral position with 20-30 degree head up, voluntary hyperventilated, and adequate anxiolytics.

RESULTS AND DISCUSSION

Case 1

History

A 24-year-old man came in with a complaint of spinning dizziness since as early as one year ago was presented to a clinic because the complaint was felt to be more aggravating with time and did not respond to therapy. In mid-November 2021, the right eye appeared to be protruding and became bigger in recent months. The right eye experienced vision loss, while the left eye vision experienced blurred vision. Complaints of fainting, convulsions, nausea, and vomiting were absent. Because of thi complaint, the patient was referred to the Neurosurgery Clinic of the Santosa Hospital Bandung Central Indonesia. Patient then underwent an MRI examination with contrast and was diagnosed to have a retroorbital tumor due to a synonasal tumor, with a differential diagnosis of rhabdomyosarcoma. The patient then received his first craniotomy surgery on February 17, 2022, followed by radiotherapy sessions. After the radiotherapy was completed, the swelling of the eyes got worse and on August 16, 2022, the patient was planned to undergo redo craniotomy.

Physical Examination

On physical examination, a body weight of 60 kg and a height of 160 cm were recorded. Patient was composmentis, GCS 15, with a blood pressure of 122/72 mmHg, a pulse rate of 75 x/min regular, a respiratory rate of 20 x/min, and an oxygen saturation of 99% with free air. Further assessment showed an Airway Mallampati of 2, good flexion movements and extensions of the neck and temporomandibular joints, and no wheezing and ronchi auscultation. The visual acuities of the right eye and left eye were 0 and 3/60, respectively. There appeared to be a mass of the size of a tennis ball on the right eye.

Supporting Examinations

On photo examination, the thoracic AP was normal. The ECG presented sinus rhythm (78 x/min) while the MRI examination of the head with contrast demonstrated a lobulated oblong round mass measuring 12x 7.3x 12.5 cm that pressed and deliliterates the eyeball and filled the space of the right eyeball into a proptosis position and phthisis bulbi, accompanied by perifocal edema leading to a > 1.4 cm shift of the the midline to the left. In addition, the mass also suppressed the frontotemporal base to the maxilla, masseter, lateropharynx, sphenoid

sinus, ethmoidalis, and right maxillary with differential diagnoses of Glioma/Pilocytic astrocytoma/Anaplastic meningioma.

The patient was diagnosed with recidive SOL retro-orbital Post craniotomy due to suspect sinonasal tumor with ASA physical status 2 planned for re-do craniotomy removal of the tumor.

Anesthesia Management

In the operating room, the patient was positioned in a neutral 30° head up position. Preoxygenation with 100% O₂ was carried out using a face mask and induction was performed with 200 µg of fentanyl, 300 mg of thiopental, and 40 mg of intravenous rocuronium. Intubation was performed using the laryngoscope Macintosh blade no.3, followed with the installation of a spiral endotracheal tube (ETT) size 7.5 with a balloon. Anesthesia with continuous propofol 25-100 µg/kg/min intravenously and rocuronium 0.15 µg/kg intravenous intermittent bolus was applied, and the anesthesia condition was maintained using 0.6-1 vol% sevoflurane volatile anesthesia in an oxygen: Air ratio of 50%: 50% air. The monitoring during surgery was conducted by evaluating the systolic blood pressure, diastolic blood pressure, oxygen saturation, ECG waves, mean arterial pressure, and urine production through a catheter. The operation lasted for four (4) hours and the amount of bleeding and diuresis was 800 cc and 2,100 cc, respectively. Patients received 1,500 cc ringerfundin balance solution, 250 cc Packed Red Cell, 30 grams mannitol, 1 gram intravenous tranexamic acid, and 10 mg intravenous dexamethasone. Surgery was performed with a pterional, zygomatic, and enucleation approach. Tumor resection of 40% was performed. The vital signs during surgery are depicted in figure 4.

Post-Operative Management

After the operation was completed, the patient's ETT was not extubated and the patient was transferred to the intensive care unit and a postoperative laboratory examination was carried out. The patient entered the intensive care unit at 5:30 p.m. The patient's breathing was controlled by a ventilator with the pressure control mode of FiO₂ 50%, RR 12x /min, P- inspiration 15, PEEP 5, VT 420-445 mL, SpO₂ 98-99% for 12 hours, and ventilator was weaned gradually until extubation at 06.00 Western Indonesian Time the next morning. While in the ICU, the patient received 25 µg/hour intravenous fentanyl as the analgesics. Other therapies in the ICU were ceftriaxone, omeprazole, mannitol, and tranexamic acid. After the ETT extubation, patient was able to breathe spontaneously with the help of 3 liters per minute O₂ via a binasal canule. Patient was in a stable hemodynamic condition with normal neurological status and visual acuity did not change from the preoperative condition. The patient was then transferred to a regular room and treated for three days before the patient was discharged and continued treatments as an outpatient.

Case 2

History

A 43-year-old female patient weighing 60 kg had experienced severe headaches, especially in the left frontal area, and a sharp decrease in vision in both eyes since 6 months before entering the hospital. There were no signs of increased intracranial pressure and other

neurological deficits. Three months before entering the hospital, the patient had undergone surgical removal of a tumor due to meningiomas in the left temporo-frontal region at the Santosa Hospital Bandung Central Indonesia with complaints of headaches. However, after being discharged from the hospital, the patient experienced the same complaint so he returned to the hospital. A history of high blood disease and diabetes was refuted. A history of asthma and allergies to food and medications was also refuted.

Physical Examinations

On physical examination, a body weight of 60 kg and a height of 160 cm were recorded. The general state of the patient reflected GCS 15, with a blood pressure of 125/88 mmHg, a pulse rate of regular 85 x/min, a respiratory rate of 18 x/min, and an oxygen saturation of 98% of free air. Patient was defined with Airway Mallampati 2, with good flexion movements and extensions of the neck and temporomandibular joints. No wheezing and ronchi auscultations were observed. The visual acuity of the right eye was 1/300 and 1/∞ for the left eye. Laboratory examination found mild anemia with a hemoglobin level of 9.7 g /dL with other parameters within normal limits.

Supporting Examinations

From the thoracic photo it was apparent that the AP was normal while the ECG demonstrated sinus rhythm of 86 x/min. A CT-scan of the head showed the presence of residual inhomogenous solid mass that involved the left temporofrontalis concavity measuring 7.70 x 6.80 x 7.16 cm which urged the anterior falx cerebri, suprasellar, left paracellular, and part of the tumor mass to herniate to the post-operation bone defect area, triggering periphocal edema and the narrowing corticalis sulci and sylvii fissures. In addition, the right and left lateralis ventricles and left parts of the anterior choroid and ventricle III were also narrowed and pressed. The patient was diagnosed with recidive SOL supratentorial at regio temporo-frontalis sinistra due to suspect convexity of meningioma with physical status ASA 2 planned for redo-craniotomy removal of the tumor.

Anesthesia Management

In the operating room, the patient was positioned in a neutral 30° head up position. Preoxygenation with 100% O₂ was carried out using a face mask and induction was performed with 150 µg fentanyl, 300 mg thiopental, and 50 mg intravenous rocuronium. Intubation was performed using a Macintosh laryngoscope with a spiral endotracheal tube (ETT) size 7.0 with a balloon. Anesthesia was performed using 25-50 µg/kg/min intravenous continuous propofol, 10 µg/kg/min intravenous rocuronium, and 0.8-1 vol% volatile anesthesia sevoflurane with an oxygen:air ratio of 50%:50%. The monitoring during surgery was performed through an evaluation of systolic blood pressure, diastolic, oxygen saturation, ECG waves, mean arterial pressure, and urine production through catheter. The operation lasted 6.5 hours with the supination position. The amount of bleeding was 1,000 cc and diuresis was 1,200 cc. Patients received 500 cc of ringerfundin balance solution, 1,500 cc of colloids, 900 cc of Packed Red Cell (PRC), 40 grams of mannitol, and 10 mg of dexamethasone. When the periosteum was opened, the dura did not appear to be tense and when the dura was opened, a slack brain was observed. The tumor mass was found in the sinister temporo-frontal region, white in color and

easily bled. A resection of 60% of the tumor was then performed. The vital signs during surgery are depicted in figure 3. The anesthetic techniques and drugs performed on these two patients were similar.

Post-Operative Management

The post-operative patient was admitted to the Intensive Care Unit (ICU) for 2 days before moving into the ward. On the first day in the ICU, the patient entered at 23:00 under ventilator control (pressure control, FiO₂ 50%, RR 14x/min, P-inspiration 14, PEEP 5, VT 400-420 mL, SpO₂ 98-99%) for 9 hours and weaning was carried out gradually until extubation at 10:00 am. While in the ICU, the patient received 25 µg/hour intravenous fentanyl. Other therapies in the ICU were ceftriaxone, omeprazole, mannitol, and tranexamic acid. On the second day in the ICU, the patient was able to breathe spontaneously with 3 liters of oxygen through a binasal cannula. Her hemodynamic condition was stable with no decrease in the neurological status. The patient was then transferred to a regular ward and treated for five days before being discharged.

Discussion

Results of presurgical examinations will determine the overall outcome of a patient. The following considerations should be taken for patients with brain tumors who are going to undergo a surgery: presence of complaints and signs of period effects and increased intracranial pressure (ICP); possible surgical problems; possible anesthesia problems; specific challenges/problems (intraoperative hemorrhage, seizures, air embolism); pathophysiology of increased ICP, brain perfusion and cerebral blood flow; anesthetic effect on ICP; cerebral perfusion pressure (CPP); CMRO₂; decrease in ICP; and swelling of the brain (Bisri & Bisri, 2016; N. J. Bruder & Ravussin, 2012; N. Bruder & Ravussin, 2017).

The target of anesthesia is to protect the brain from secondary injury. Risk factors for anesthesia are the presence of hypoxia, hypercapnia, anemia, and hypotension. Anesthetic techniques are aimed at maintaining autoregulation and response to CO₂, maximizing the brain slack to reduce retraction pressure (Bisri & Bisri, 2016; N. J. Bruder & Ravussin, 2012; N. Bruder & Ravussin, 2017). Pre-operative examinations include investigations that answer the following questions (Bisri & Bisri, 2016): What is the current state of the patient? Are there any symptoms of increased ICP, such as headache, nausea, vomiting, blurred vision, and somnolence, and symptoms of local suppression of the tumor, such as the presence of seizures, and focal neurological deficits? Where is the location of the tumor? What is the diagnosis of the tumor? What therapies have been given? Has the patient undergone craniotomy before? Furthermore, there are criteria to be considered, including the size of the tumor, the location of the tumor and the presence of a midline shift. If two of these three criteria are observed in a patient, the patient should be treated in the ICU/NeuroICU, remain to be intubated after the surgery, and a mechanical ventilation should be installed (Bisri & Bisri, 2016).

The target of anesthesia for brain tumor surgery, both for the first and redo surgery, is to get a slack brain, prevent a rise in ICP, and perform brain protection and resuscitation (Bisri & Bisri, 2016).

The target of fluid administration is isoosmolar normovolemia condition. In the first case, the total fluid input was 500 cc Ringer Lactate and 1,000 cc ringerfundin with a blood loss of

800 cc. The first patient's operation lasted for 4 hours, while the second patient lost 1,000 cc of blood and the operation lasted for 6.5 hours. Hemodynamics is in a stable condition obtained during surgery which enable the patient to be transferred to an intensive care ward. During the stay in the intensive care, awareness, spontaneous and adequate breathing that is free from the influence of the effects of residual muscle-relaxant drugs, pulse rate, blood pressure, skin color, and body temperature must be monitored.

The criteria for extubation to be observed are the neurological status/presurgical consciousness, the amount of bleeding (Ht <24%), the presence of intraoperative catastrophic, and the duration of the operation that is < 7 hours. In the two cases, the two post-dissected patients post-dissected remain intubated, and can only be extubated on the next day (Bisri & Bisri, 2016; N. J. Bruder & Ravussin, 2012; N. Bruder & Ravussin, 2017).

Patients with cranial tumors experience an increase in ICP, resulting in headaches, nausea, vomiting, ataxia, syncope, and visual and cognitive impairments. Focal neurological signs appear due to mass compression in the surrounding area. Visual impairment occurs in a predictable pattern according to the location of masses on the optic nerve, optical channels, optical radiation, and areas of the visual cortex (Kulsum & Suryadi, 2021). In terms of surgical approaches to orbital tumors, there are three surgical approaches that can be applied: transorbital, extraorbital-transcranial, and endonasal transcranial approaches. The transorbital approach is commonly used for tumors in the anterior part of the orbit, while the extraorbital-transcranial approach is used for lesions located on the posterior part of the orbita, lateral and superior optic nervus. The endonasal transcranial approach can be used for tumors located in the medial part of the orbit (Kılıç, 2018).

The neuroanaesthesia approach is performed under the principle of "ABCDE", consisting of Airway to ensure a safe airway; Breathing by providing adequate ventilation and oxygenation; Circulation that stabilizes the cardiovascular system; Drug to avoid drugs and anesthetic measures that increase ICP; and Environment to maintain normal temperature/mild hypothermia (Bisri & Bisri, 2016).

The role of imaging in orbital mass evaluation with an emphasis on advanced imaging techniques, such as Magnetic Resonance Imaging (MRI) diffusion weighted imaging (DWI), diffusion tensor imaging (DTI), fluoro-2-deoxy-D-glucose (FDG)-positron emission tomography CT (PET CT), and positron emission tomography MRI (PET MRI), is crucial (Purohit et al., 2016).

In this patient, the MRI imaging was performed on the head with the impression of thick-walled cystic multiple times with rim enhancement in the subcortical corticocortical of the sinister temporoparietalis lobe accompanied by periphocal edema that narrows the sinister lateral ventricle and ventricle 3, and urging the interhemispheric fissure that leads to a midline shift towards the dextra and hydrocephalus communicans. The patient underwent the primary craniotomy on February 17, 2022. A craniotomy is a surgical procedure that involves partial removal of the skull to expose the brain and perform intracranial procedures. The most common pathological conditions that require craniotomy are brain tumors, aneurysms, arteriovenous malformations, subdural empiema, subdural hematomas, and intracerebral hematomas. The surgical procedure to reconstruct and place the bone cover back into the skull during the second intervention is known as cranioplasty (Fernández-de & de Jesus, 2022).

Intraoperative anesthesia management is important for the evaluation and minimization of intraoperative risks (Keown et al., 2022). Intravenous induction (IV) with thiopentone or propofol and neuromuscular blocks to facilitate endotracheal intubation is ideal in patients with increased intracranial pressure. Bolus propofol can be administered to prevent a pressure response in tracheal intubation. Volatile anesthesia leads to an increase in CBF and ICP; therefore, ventilation should be controlled as early as possible and mild hyperventilation is performed to prevent an increase in ICP. Patients at risk of aspiration should undergo induction of anesthesia with propofol, followed by rapid growth of working muscles using agents such as succinylcholine or rocuronium (Rath & Dash, 2012). In Indonesia, succinylcholine is not available, so rocuronium bromide is used.

Anesthesia is maintained either with low end-tidal volatile agents with a minimum alveolar concentration (MAC) < 1 or with total intravenous anaesthesia (TIVA), along with short-acting opioids (fentanyl or remifentanyl), N₂O inhalation, and controlled ventilation (Soriano & McManus, 2010). Due to various considerations, in our hospitals do not use N₂O for neurosurgery. Sevoflurane is used for the management of maintenance anesthetic during neurosurgical procedures by providing induction and rapid recovery. Neuromuscular blockade with non-depolarizing muscle growth to prevent patient movement and minimize the amount of anesthetic agent is necessary in this type of procedure; thus, a muscle-growing agent such as succinylcholine or rocuronium is used (Rath & Dash, 2012).

The patient in this case underwent redo craniotomy because of the increasing swelling of the eyes. Degree of reoperation depends on risk factors such as comorbidities, initial disorders, and neurological status. Surgical outcomes and the degree of complication are some of the most important factors to consider when choosing a single surgical approach. The overall morbidity and mortality in neurosurgical operative procedures are higher than other surgical areas (Dasenbrock et al., 2017). The National Surgical Quality Improvement Program (NSQIP) data show that the most common craniotomy complications include pneumonia, surgical site infections, and surgical redo (Raghib et al., 2022). The reoperative rate is defined as the percentage of patients who return to the operating room within 30 days after the initial craniotomy and undergo a repeat craniotomy procedure (redo). Some common indications for reoperative surgery after craniotomy are postoperative bleeding, incomplete tumor resection, increased intracranial pressure postoperatively, shunt failure, superficial or intracranial surgical site infection, and postoperative cerebrospinal fluid leakage (Raghib et al., 2022; Schipmann et al., 2019).

Other factors associated with an increase in reoperative reaction rates include thrombocytopenia, hypertension, emergency surgery, long intraoperative time, dependent functional status, and comorbidities such as obesity (Raghib et al., 2022). Morbidity is defined as a significant decrease in the Karnofsky Performance Score (KPS). Overall, the risk of morbidity does not increase significantly after recurrent craniotomy and microsurgery for tumor removal. Mortality and complications are not differ significantly between redo craniotomy surgery and primary surgery (Raghib et al., 2022). A previous study showed better survivals after re-craniotomy in glioblastoma over a 10-year period; however, their time to repeat the craniotomy is not determined by any particular limit (Chen et al., 2016). ASA is a classification for assessing patients according to general health for anesthesia and surgery. The ASA classification comprises of five categories, with a score that ranges range from 1

(representing a healthy person) to 5 (representing patients who are not expected to survive longer than 24 hours). Studies show that ASA 2 has good results, and ASA 2 has a figure 5.6 times less likely to survive compared to ASA 3 after a re-craniotomy, and ASA 3 patients are 0.2 times less likely to survive where patients have ASA 3. The first patient has ASA physical status 2, while the second patient has ASA physical status 2 (Adigun et al., 2011). The awareness status measured in the GCS score of less than 9 has poor results, while a GCS between 9 and 15 leads to 85.7% good results and the difference between the two is statistically significant. This suggests that patients with a GCS of less than 8 are 19.6 times less likely to survive (Adigun et al., 2011). Both patients in this case report had a GCS score of 15.

The first patient underwent the redo craniotomy surgery with a duration of more or less 4 hours while the second patient underwent a 6-hour surgery. During surgery, the hemodynamic status of the patient stabilized without complications. Intraoperative parameters are measured by blood pressure and heart rate, since intraoperative hypotension is a common intraoperative side effect and has been reported to be associated with adverse perioperative outcomes. Better management of intraoperative anesthesia may have a greater effect on long-term outcomes (Adigun et al., 2011).

A presurgical neurological evaluation should be carried out in the form of anamnesis about the presence of seizures, increased ICT (headache, nausea, vomiting, blurred vision), focal neurological deficits (motor or sensory deficit), hydration (fluid intake, diuretics), and medications administered such as steroids, antiepileptic drugs, and their adverse effects (N. J. Bruder & Ravussin, 2012; N. Bruder & Ravussin, 2017). Accompanying medical conditions are assessed by performing a physical examination to evaluate presurgical neurological condition, mental status, level of consciousness, papillary edema, Cushing's response (hypertension, bradycardia), pupil size, speech deficit, Glasgow Coma Scale (GCS) score, and focal deficit. Pre-dissected neurological evaluation is performed radiologically (CT or MRI-scan) by looking at the size and location of the tumor (close to large blood vessels or eloquent areas of the brain) as well as the mass effect of the presence of midline shift, temporal or frontal herniation, basal loss of CSF cisterna, or hydrocephalus (N. J. Bruder & Ravussin, 2012; N. Bruder & Ravussin, 2017).

In pre-operative preparation, patients who have no signs of ICP increase may benefit from oral premedication with small doses of benzodiazepines. Vascular access: central venous access, arterial cannulation. Monitoring: cardiovascular, air embolism, neuromuscular blockade, metabolic, intracranial, cerebral function, ICP monitoring. The recommendations for anesthetic induction are as follows: Adequate preoperative anxiolysis, preoxygenation, provisions of fentanyl, 1.25-2.5 mg/kg or total 3-6 ug/kg propofol and nondepolarizing muscle relaxant, hyperventilation (PaCO₂ 35 mmHg), and then intubation. Recommended maintenance of anesthesia involves 0.5-1.5%, sevoflurane or 3-6% desflurane, 50-150 mcg/kg/min propofol, and analgesia with fentanyl. When installing the pin holder, local anesthesia or, additionally, intravenous fentanyl is given. Head is positioned in a 10-20 degree head-up position to free the jugular vein and 0.5-0.75 g/kg mannitol is given within 20 minutes or lumbar drainage is performed. The target is normovolemia fluid with isotonic crystalloids or 6% HES to replace blood loss. The concept of chemical brain retractor with mild hyperosmolarity (before lifting the head bone give 20% mannitol 0.5-0.75 mg/kg or NaCl 7.5% 2-3 mL/kg), perform mild hyperventilation, adequate head-up position (10-20 degrees),

intravenous anesthesia (propofol), normotension or mild hypertension (MAP 100 mmHg), lumbar CSF drainage, drainage of cerebral veins by means of free jugular veins and avoid brain retractors (Bisri & Bisri, 2016; N. J. Bruder & Ravussin, 2012; N. Bruder & Ravussin, 2017).

Indications of redo craniotomy action are postoperative bleeding, incomplete tumor resection, increased intracranial pressure postoperatively, shunt failure, infection of superficial or intracranial surgical sites, leakage of postoperative cerebrospinal fluid and regrowth of the tumor.

CONCLUSION

The first patient's bleeding volume was 800 mL, while the second patient's bleeding volume was 1,000 mL. The fluid balance was kept by using the ringerfundin balancing solution. The first and second patients' operations took 4 and 6.5 hours, respectively, to complete. For surgery, patients received care in the ICU for a day while using mechanical ventilation before being transferred to the ward following extubation.

In both cases, redo craniotomy was performed due to tumor regrowth that gains bigger size rapidly. The procedure for redo craniotomy carries the same level of morbidity and mortality as the primary craniotomy action. However, in these patients, the redo craniotomy procedure was performed in the hope that the tumor could be removed as a whole, leading to improved quality of life. Better intraoperative care, improved surgical skills, surgical equipment, and better intensive care support are likely to improve outcomes in patients with redo craniotomy.

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