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PREOPERATIVE PREDICTORS OF ANAESTHETIC OUTCOME OF PATIENTS UNDERGOING POSTERIOR FOSSA TUMOR SURGERY : A PROSPECTIVE STUDY

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ABSTRACT

BACKGROUND : The posterior fossa has a dense collection of critical neurovascular structures passing through a rigidly confined space. The anaesthetic outcome of patients undergoing posterior fossa surgery depends on various factors including patient, surgical and anaesthetic factors. We studied the effect of multiple preoperative factors on anaesthetic outcome of these patients so as to whether they would be extubated, kept on T-piece or electively ventilated.

METHODS : Following ethical approval, a prospective observational study was carried out in 120 cases over a period of 2 years. Patients of either gender, belonging to ASA I & ASA II status undergoing elective craniotomy for posterior fossa tumors were included in the study. Exclusion criteria included ASA III & ASA IV patients, age < 18 & > 60 years and GCS < 8. Demographic data and various factors expected to involve the outcome were collected and analyzed.

RESULTS : Of the 120 patients studied, 78 (65%) patients were extubated on table and 42 (35%) patients were either put on T-piece or required postoperative ventilation. 35 preoperative variables were transformed into binary data and subjected to multiple regression based on R-squared method to select predictive variables. 7 preoperative variables including loss of protective airway reflexes, h/o aspiration, GCS < 13, motor deficits, steroid use, size > 3 cms & hyponatremia were found to be significant. The selected variables were used to develop a logistic regression model.

CONCLUSION : The postoperative care of the patient can be planned. Steps can be taken to correct or minimize these factors that could lead to an adverse outcome.

KEYWORDS : anaesthetic outcome; posterior fossa surgery; preoperative predictors; neuroanaesthesia.

INTRODUCTION

Anaesthesia for neurosurgery presents special considerations. The brain is enclosed in a rigid skull and majority of craniotomies are performed for space occupying lesions. At the same time, the brain is a highly vascular organ presenting potential for massive haemorrhage. Tolerance of the brain to interruption of substrate delivery is minimal. The posterior fossa has a dense collection of critical neurovascular structures passing through a rigidly confined space.

Anaesthetics cause dose-related and reversible alterations in many aspects of cerebral physiology, including cerebral blood flow (CBF), cerebral metabolic rate (CMR), and electro physiological function (EEG, evoked responses)[1,2,3]. The effects of the anaesthetic drugs and techniques have the potential to adversely affect the diseased brain and performance of the neurosurgical procedure and are therefore of clinical importance in patients with neurologic disease.

As there are many studies that show the factors effecting surgical outcome and some studies to show the influence of individual factors like ICP, blood pressure, CBF, temperature, glycemic control, blood loss, duration of surgery and GCS on the outcome[4,5,6,7,8], we decided to study the effect of multiple preoperative factors on anaesthetic outcome of patients coming for posterior fossa tumor surgery so as to whether they would be extubated, kept on T-piece or electively ventilated.

The aim of the study was to identify those factors that would have greater overall effect on the anaesthetic outcome and which would help us predict the need for post operative mechanical ventilation, ICU stay and also help in correcting or minimizing (if possible) these factors contributing to adverse outcome. The study would also help us in planning the post operative care of the patient undergoing surgery and also explaining to the patient and the attendants the possible need for post operative mechanical ventilation as a consequence of the preoperative factors, if any.

MATERIALS AND METHODS

Following institutional ethical committee approval and informed consent, a prospective observational study was carried out in 120 cases over a period of 3 years ranging from September 2015 to August 2018. Patients of either gender, belonging to ASA I & ASA II status undergoing elective craniotomy for posterior fossa tumors were included in the study. Exclusion criteria included ASA III & ASA IV patients, age < 18 & > 60 years and patients with GCS < 8. Demographic data and various factors expected to involve the outcome were collected and analyzed.

Preoperative factors included age, sex, h/o headache, blurred vision, vomiting, cerebellar signs, loss of airway reflexes, aspiration, motor deficits, sensory deficits, cranial nerve deficits, GCS (13-15 or < 13), comorbidities like HTN, DM, asthma, COPD, CAD, CVA, CKD, h/o smoking/ alcohol, radiotherapy, chemotherapy, steroid use, antiepileptic medication use, imageology (CT or MRI) findings for location, size (> 13.5 cm^3), peritumoral edema, midline shift,etc., preoperative investigations like haemoglobin (< 9 gm% or 9 gm% and above), blood urea (cutoff 40 mg/dl), serum creatinine (cutoff 1.2 mg/dl), blood sugar (< 80 mg/dl or 80-180 mg/dl or > 180 mg/dl), serum electrolytes (with normal taken as Na^+ 130-145 mEq/L, K^+ 3.5-5 mEq/L).

All the patients were premedicated with 150 mg Ranitidine and 0.5 mg Alprazolam on the night before surgery. All patients were kept fasting overnight. In the operation theatre after connecting the patient to standard monitoring consisting of ECG and pulse oximeter, IV access was sought consisting of a minimum of two large bore cannulae (16-18 G). A 20 G arterial switch cannula & 16 or 18 G cavafix were secured before induction under local anaesthesia and strict asepsis. All patients were induced with Thiopentone sodium 5 to 6 mg per kg body weight titrated to the loss of eye lash reflex along with Fentanyl 2 µg per kg body weight. Patients were intubated after administering Rocuronium bromide 0.80 mg per kg body weight with appropriate sized cuffed portex endotracheal tube & connected to ETCO2 analyser. A temperature probe was introduced after induction into the nasopharynx of the patient to note core body temperature. Urinary bladder was catheterised after induction to monitor urine output. Anaesthesia was maintained with Isoflurane 0.6 to 1.2 % in a mixture of 66% Nitrous oxide and 33% Oxygen. Muscle relaxation was maintained with infusion consisting of Atracurium 1:1 & Fentanyl 1:1 at 12 to 15 ml per hr. Isoflurane was discontinued at the time of skin closure and nitrous oxide was discontinued after application of head dressing. At the end of surgery after observing respiratory attempts neuromuscular blockade was reversed with a mixture of Neostigmine 0.05mg/kg and Glycopyrrolate 0.01mg/kg. Patients were extubated after meeting regular extubation criteria (like return of consciousness, adequate muscle power, sustained head lift). Otherwise patients with inadequate recovery were sent to ICU for mechanical ventilation. The time to extubation was noted postoperatively.

The study was conducted by enrolling 120 patients after the power analysis with power of $\beta = 0.82$, $\alpha = 0.05$ and statistics were done by using NCSS software version 2007. Demographic data and tumor type and site were presented in percentages. Preoperative parameters were transformed into binary data and significant predictors of outcome were identified by using McHenry's R^2 (coefficient of determinant)

method[9]. Variables selected were used to develop a logistic model using preoperative predictors. The model was assessed by sensitivity, specificity, overall accuracy and area under the ROC (receiver operator characteristic) curve.

RESULTS

There were 50 (41.67%) male patients, and 70 (58.33%) females in the study (Table-1). 78 (65%) patients were extubated on table and 42 (35%) patients were either put on T-piece or required postoperative ventilation (Table-1) out of 120 patients studied. Commonest type of tumor being Schwannomas (52.5%) followed by Haemangiomas (15.8%) (Table-2). Commonest site being Cerebello-pontine angle (62.5%) (Table-3).

Table-1. Demographic data

Total no of patients	120
Males	50 (41.67%)
Females	70 (58.33%)
Mean age ± SD	34.66 ±11.17 yrs
Mean weight ± SD	57.58 ±10.16
Number of patients extubated	78 (65%)
Number of patients required postoperative ventilation	42 (35%)

SD – Standard Deviation

Table-2. Types of Posterior Fossa tumors

Type of tumor	Number of cases
Schwannomas	63 (52.5%)
Haemangiomas	19 (15.8%)
Epidermoids	12 (10%)
Meningiomas	9 (7.5%)
Gliomas	6 (5%)
Other SOLs	11 (9.1%)

SOL – Space Occupying Lesion

Table-3. Location of the Posterior Fossa tumors

Site	Number of cases
CP angle	75 (62.5%)
Cerebellum	27 (22.5%)
Brainstem	9 (7.5%)
Occipital lobe	2 (2.4%)
Others	7 (5.9%)
Right sided tumors	67 (55.9%)
Left sided tumors	53 (44.1%)

35 preoperative variables were transformed into binary data and subjected to multiple regression based on R-squared method to select predictive variables. 7 preoperative variables including loss of protective airway reflexes, h/o aspiration, GCS < 13, motor deficits, steroid use, size > 3 cms & hyponatremia were found to be significant.

The logistic regression model was developed for predicting the anaesthesia outcome.

Preoperative logistic model

Model for outcome = 1 (Ventilated)

7.314 + (10.335 × Aspirated) + (13.247 × GCS) + (9.77 × Hyponatremia) – (7.129 × Motor deficit) – (9.280 × Loss of protective airway reflexes) + (1.399 × Size) + (1.120 × Steroid use) The model had a sensitivity, specificity, accuracy and area under the ROC curve of 79%, 85%, 81% and 0.82 (Figure-1) respectively.

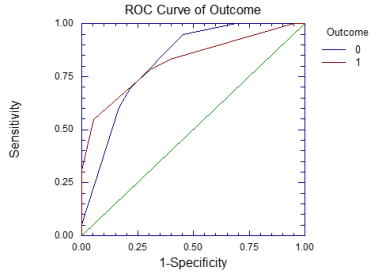

Figure-1. ROC curve for preoperative variables model. ROC – Receiver Operator Characteristic, AUC – Area Under the Curve, 0 – extubated, 1 – put on T-piece or electively ventilated.

Of the 42 patients who were not extubated on table, 9 (7.5%) patients were extubated on the day of surgery itself in the postoperative ward, 28 (23.3%) patients were extubated on POD1, 1 (0.85%) patient was extubated on POD2, 1 (0.85%) patient was extubated after 3 days and 3 (2.5%) patients could not be extubated and these died before discharge (Figure-2). Poor GCS was the reason for not to extubate 2 out of five cases that still required elective ventilation on POD1. One was extubated on POD2 and the other after 3 days.

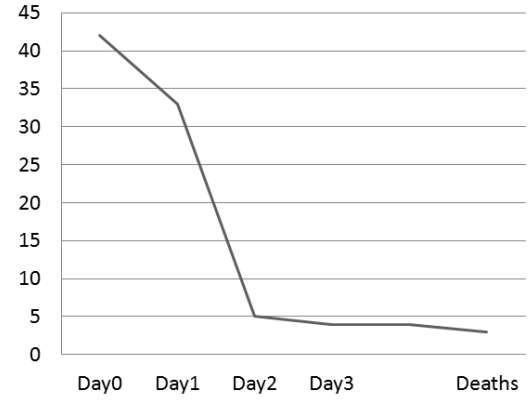

Figure-2. Number of patients ventilated postoperatively and death before discharge.

DISCUSSION

The rationale behind a "rapid-awakening-strategy" after craniotomy with general anaesthesia is that an early diagnosis of postoperative neurological complications is essential to limit potentially devastating consequences and finally improve patient outcome.

The ability to detect preoperatively which patients are at higher risk for delayed emergence can be of great advantage in planning the postoperative management of these patients. Decisions concerning the need for postoperative ventilation or radiological examination can be facilitated. It helps in early detection of post-operative surgical complications, leads to less catecholamine release and decreased expense of intensive care unit (ICU) admission. It also helps us in preparing patient and patient's attendants for the possible need of postoperative elective ventilation and alleviating their anxiety. The ability to predict preoperatively which patient requires elective ventilation in the postoperative period can help us in reserving bed and ventilator in ICU and also can avoid unnecessary blocking of the ventilator, where these resources are limited.

Patients with delayed emergence from anaesthesia after intracranial surgery often need intensive postoperative care[10]. Extubation failure can prolong the duration of mechanical ventilation, increases the length of ICU and hospital stay, increases the need for tracheostomy, and is associated with higher hospital morbidity and mortality. The most feared complications after intracranial surgery are development of an intracranial haematoma and massive oedema. Both may aggravate cerebral hypoperfusion and brain injury. Arterial hypertension via catecholamine release or sympathetic stimulation and hypercapnia may be predisposing factors[11] for expansion of hematoma. The severe injury of mesencephalon, pons, and medulla oblongata (brain-stem structures) results in brain death and may be initially diagnosed by examination of brain-stem reflexes. The loss of brain-stem reflexes occurs in rostral-to-caudal direction, medulla oblongata being the last one to be affected (patient with intact medulla still maintains normal blood pressure and develops tachycardia after atropine administration)[12]. Delayed awakening may be caused by an array of benign or life threatening conditions[13-16]; however, because of its potentially severe consequences, brain injury should be at the top of the differential diagnostic list after neurosurgical procedures. For that reason, patients who do not awaken promptly are urgently subjected to diagnostic procedures.

As patients on mechanical ventilation can have intense sympathetic activity due to inadequate sedation or during weaning from mechanical ventilation, this increases the possibility of secondary insult to brain in the form of increase in hematoma size or fresh intracranial bleed . Thus, early recovery and extubation in the operating room is the preferred method when the preoperative state of consciousness is relatively normal and surgery does not involve critical brain areas or

extensive manipulation.

In our study 65% of the patients were extubated on table, and an additional 7.5% were extubated on the day of surgery. A study conducted in Siriraj hospital[8] in 2010 reported that 89% were suitable for extubation after intracranial surgery. The percentage of extubations is higher in this study when compared to other studies. But all the types of craniotomies including supratentorial and infratentorial were included in this sudy. The early extubation was defined as the patients who were extubated within 6 hours after the operation finished. In our study 65% of the cases were extubated immediately after the surgery was over. Another explanation for this discrepancy in extubation is that all our study cases were posterior fossa tumors. These tumors are in close proximity to the brainstem and this could lead to respiratory insufficiency in the postoperative period[12]. Prolonged surgery when compared to supratentorial surgeries in view of position difficulties and difficulties in approach could also be the reason. Loss of function of the lower cranial nerves that could be involved here could lead to loss of airway reflexes and this could be another cause as has been proved in our study (loss of airway reflexes and h/o aspiration were significant in relation to the outcome).

In our study GCS ≤ 12 was independently associated with the delayed extubation. We used Glasgow Coma Scale in our study because of its reproducibility and universal acceptance. Andrew M. Namen, E. et al studied in neurosurgical patients in ICU to findout the predictors of extubation and multivariate analysis showed that Glasgow Coma Scale (GCS) score < 8 ($p < 0.0001$) and partial pressure of arterial oxygen/ fraction of inspired oxygen ratio ($p < 0.0001$) were associated with extubation success[17]. In our study patients with GCS < 8 were excluded from the study because these patients were most of the times intubated preoperatively and extubation in these patients with altered consciousness was not advisable at the end of surgery.

Loss of protective airway reflexes and a history of aspiration have also come significant as predictors of extubation in our study. Irritation and pressure on posterior fossa structures, particularly of cranial nerves IX, X, and XII, can result in loss of control and patency of the upper airway, and swelling of the brainstem can result in impairment of cranial nerve function and respiratory drive[18-20]. The posterior fossa is a small space, and its compensatory latitudes are even more limited than those of the supratentorial space. Relatively little swelling can result in disorders of consciousness, respiratory drive, and cardiomotor function. Procedures involving dissection on the floor of the fourth ventricle entail the possibility of injury to cranial nerve nuclei or postoperative swelling in that region, or both. This could further aggravate the situation and could lead to problem in maintaining an airway in the postoperative period. So, a meeting should occur between the anesthesiologist and the surgeon to make decisions as to whether extubation is appropriate, and where postoperative observation should occur (i.e., ICU or non-ICU)[21].

Size of the tumor also has a role to play in planning for extubation according to our study. Larger the tumor, the more time it will take to resect it and studies have shown that prolonged duration of surgery in these cases can lead to a delayed emergence from anaesthesia[22-24].

A study in Siriraj hospital has shown a delayed recovery in patients whose surgery went on for more than 5 hours[8]. A larger tumor would most likely have more effects as there is a higher likeliness of pressure on the surrounding structures. Schubert et al in their study concluded that patients undergoing craniotomy for large intracranial mass lesions awaken more slowly than patients after spinal surgery or craniotomy for small brain tumors. Large tumors could cause compression on the brainstem and lead to loss of airway reflexes which would make extubation difficult in the immediate postoperative period. A large lesion could be the cause for a midline shift and cause impairment of functions. Nicole et al showed that neurologic signs and symptoms are often the initial presenting features of a primary brain tumor and may also emerge during the course of therapy or as late effects of the tumor and its treatment. Variables that influence the development of such neurologic complications include the type, size, and location of the tumor, the patient's age at diagnosis, and the treatment modalities used[25]. Obstructive hydrocephalus can develop in patients with a large tumor leading to an increased ICP which in turn could be the cause for poor GCS leading to a delayed recovery.

In our study, the use of steroids in the preoperative period has shown to cause delayed recovery. Brain oedema in brain tumors is the result of leakage of plasma into the parenchyma through dysfunctional cerebral capillaries. Vascular endothelial growth factor-induced dysfunction of tight junction proteins probably plays an important role in the formation of oedema. Corticosteroids are the mainstay of treatment of brain oedema. When possible, corticosteroids are used in a low dose (*eg,* 4 mg dexamethasone daily) to avoid serious side effects such as myopathy or diabetes. Higher doses of dexamethasone (16 mg/day or more), sometimes together with osmotherapy (mannitol, glycerol) or surgery, may be used in emergency situations. On tapering, one should be aware of the possible development of corticosteroid dependency or withdrawal effects[26,27]. Hyperglycemia could occur intraoperatively in patients using steroids[28,29]. Intraoperative hyperglycemia can in turn exacerbate neurological damage[30-32]. Peritumoral oedema could again have pressure effects on the surrounding structures as described earlier leading to a delayed emergence.

In our study preoperative motor deficits had shown significant influence on outcome. In patients coming for infratentorial surgeries motor deficits indicate either a previous cerebrovascular accident (stroke) or multiple intracranial pathologies or large infratentorial lesions extending into the supratentorial region with or without peritumoral oedema because motor deficits are usually the result of insult to the motor cortex that is present in the supratentorial region[33]. As mentioned earlier, the large size of tumor, peritumoral oedema and other higher functions altered along with motor deficits could be a cause for delayed recovery[34].

Hyponatremia was one of the preoperative variables that had significance. Mild hyponatremia is usually asymptomatic, but serum sodium concentration <120 mmol/litre will cause confusion and irritability. Serum sodium concentration <110 mmol/litre causes seizures, coma and increased mortality. The causes of hyponatremia are multiple; however, those pertinent to anaesthesia are the conditions that may develop during operation. Inappropriate anti-diuretic hormone secretion (SIADH) can result from brain trauma, subarachnoid haemorrhage and administration of drugs (e.g. opioids, haloperidol, vasopressin). Cerebral salt-wasting syndrome may also occur in the brain injured patient, and infusion of mannitol can dehydrate. Cerebral salt-wasting syndrome describes sodium loss from the kidneys in association with intracranial pathology, thought to be mediated by atrial natriuretic peptide secretion. Cerebral oedema results in cerebral irritation and coma. Thus hyponatremia can cause delayed emergence[35].

In our study group patients hyponatremia could be the result of brain injury or use of drugs like diuretics and mannitol to decrease ICP. So, care should be taken and correction should be done for better outcome. Rapid correction is also not warranted as it can cause central pontine myelinolysis that could further aggravate the situation[36,37].

Limitation of the study was that a study contemplating in multiple centres would have been more authentic.

CONCLUSION

Delayed emergence from anaesthesia remains a major cause of concern both for neuroanaesthetists as well as surgeons. Early emergence from anaesthesia is essential so that patient can cooperate with a postoperative neurological examination. Residual anaesthesia may either give the false impression of a neurological deficit, or prevent the early diagnosis of a developing intracranial lesion like haematoma, herniation and oedema. Patients who have delayed emergence from anaesthesia after intracranial surgery are frequently subjected to emergency computerized tomography and even cerebral angiography. They are also at greater risk for airway obstruction, hypoxemia, hypercarbia, and aspiration, thus demanding a more intensive postoperative care. The model developed gives us an insight into the possibility of patient emergence from anaesthesia. A multicenter study can be done for an external validation of this model.

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