

Morbidity and Mortality of Major Cranial Surgery: An Institutional Based Prospective Observational Study

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ABSTRACT

INTRODUCTION: Surgical complications are often broadly defined as "any deviation from the normal post-operative course." This definition is clearly subjective and prone to inter-observer variability. It's our first attempt to identify the post-operative status of the patients who underwent major cranial surgery in terms of morbidity and mortality and find out the preventable cause.

METHOD: This was a prospective study carried out at National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal. The patients of all age group who underwent cranial surgeries were included in the study. We analyzed post-operative neurological status and complications in terms of morbidity and mortality.

RESULT: Total of 405 cranial surgeries were carried out on 364 patients. About two-thirds of the patients (62%) were male and 38% were female. Of the cranial surgery, 133 were for brain tumors, 67 were for traumatic brain injuries, 64 were for vascular lesions, 18 were for congenital disorders and 17 were for infective diseases. Post-operative complication was noted in 27.7%. Among various complications, 13% had pulmonary complications, 5% had new onset seizures, 3% had infarctions and 2.5% had major neurologic deficits. Overall mortality rate was 11%.

CONCLUSION: Pulmonary complication is the most common complication after major cranial surgery, which is one of the preventable causes of morbidity and mortality.

KEY WORDS: Cranial surgery, Morbidity, Mortality, Tumor, Vascular.

INTRODUCTION

Surgical complications are more common than appreciated and result in substantial morbidity and mortality.¹ Specific adverse events such as surgical site infection or ventilation acquired pneumonia are often measured at an institutional level.²⁻⁴

In order to improve health outcomes by reducing complications, actual estimation of adverse events is the very initial step forward. Till date, most reports on the incidence of adverse events in cranial surgery

have been retrospective and dependent on data abstraction from hospital based administrative databases. Prospectively examining the adverse events in a tertiary center would provide one estimate of anticipated complications rates.

METHOD

This was a prospective analysis of patients of all age group who underwent major cranial surgeries between in the Department of Neurosurgery, National Academy of Medical Sciences, Bir Hospital. Patients who underwent neurosurgical procedure as a part of management or treatment were included. Patients who underwent spinal surgeries and minor cranial surgeries including scalp sebaceous cyst excision, lipoma excision were excluded in our study.

Variables included in this study were age, sex, neurological status and type of lesion (neoplastic,

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vascular, congenital, infectious and trauma). All the patients included in this study were informed about the study and its objectives. Written informed consent was taken. Written permission was obtained from institutional review board (IRB) of NAMS.

All the enrolled cases were evaluated intraoperatively and post-operatively. Complications were noted if any and recorded in performa till the patients were discharged. Statistical analysis was performed using Statistical package for the social sciences (SPSS) version 23 software package.

RESULT

The study analyzed 364 patients, on the various form of cranial procedures and its complications in the form of morbidity and mortality. Ratio of male to female was 1.6:1. Mean age at operation was 40.39 ± 20 years. Among them, 61 patients were older than 60 years and 18 cases were below 1 year of age ranging from 1 to 11 months age.

Cranial surgeries were categorized as tumour, vascular, trauma, congenital and infective. However, some of the proceures including external ventricular drainage (EVD) placement, venticulo-peritoneal (VP) shunting, secondary dural repair and re-exploration of cranial surgeries were considered as separate entity. Major cases of cranial surgeries were brain tumor (133, 32.84%), followed by traumatic brain injury (67, 16.54%), vascular disease (64, 15.8%), congenital (18, 4.4%) and infective pathology (17, 4.2%). However, as part of neurosurgical management 64 patients underwent VP shunt, 38 underwent EVD placement, 2 underwent secondary dural repair and 2 underwent exploration of cranial surgery (Figure 1).

In case of infective pathology, 11 (65%) had surgical management for cerebral abscess, 4 (23%) had surgical management for tuberculous meningitis and 2 (12%) had craniotomy and excision of cerebellar abscess.

Out of 67 patients of traumatic brain injury surgeries, 44 (66%) represented the chronic subdural hematoma, 13 (19%) had acute subdural hematoma, 6 (9%) were compound depressed fracture and 4 (6%) underwent cranioplasty.

In case of vascular cranial surgery, 44 (68.75%) were aneurysm surgery who underewent microsurgical aneurysm clipping, 11 (17%) underwent craniotomy

and intracerebral hematoma evacuation, 5 (7.8%) had excision of arteriovenous malformation, 3(4.69%) had ischemic stroke and underwent decompressive craniectomy (Figure 2).

In case of neoplastic lesions, glioma represented the highest percentage 21%, followed by cerebellar space occupying lesion and meningioma 20% & 18% respectively. Sellar tumour represented 14% of the cases (Figure 3).

Among surgeries for the congenital abnormalities, Chiari I malformation cases represented majority of the cases 11 (61%), Chiari II malformation represented 3 (16%) and 2 (11%) each for basilar invagination and congenital aqueductal stenosis.

Brain swelling represented the highest 15 (52%) of intraoperative complications, followed by 8 (27.58%) of intraoperative bleeding, 4 (13.79%) of intraoperative aneurysm rupture and 2 (7%) of venous air embolism which was one of the dreadful complication in sitting position (Figure 4).

Postoperative complications represented in various forms. Pulmonary complications represented 50 (13%). Among them, tumour surgery represented highest 22 (44%) followed by vascular surgery 19 (38%). There were other postoperative complications as shown in Table 1.

Overall mortality of 42 (11.5%) were noted during the course of treatment (Figure 9). Patients who underwent aneurysm surgery according to Hunt and Hess grading, grade 1 had no mortality, and grade 3, 4, 5 represented the highest mortality. The mortality was 9 (20.45%) in aneurysm surgery (Table 2).

For the cause of mortality, aspiration pneumonia represented the highest number of 15 (34%) followed by cerebral infarction of 7 (16%). Forty percent of mortality was associated with pulmonary complication (Table 3).

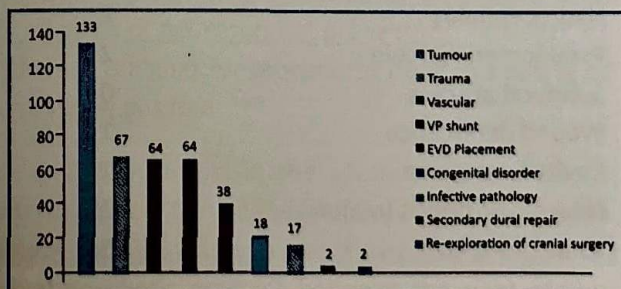


Figure 1: Distribution of cranial surgery

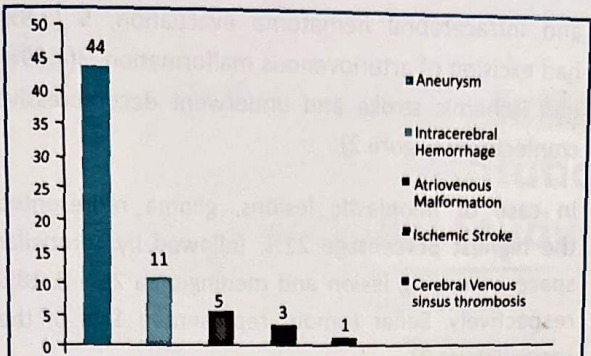


Figure 2: Distribution of cranial surgery for vascular disease

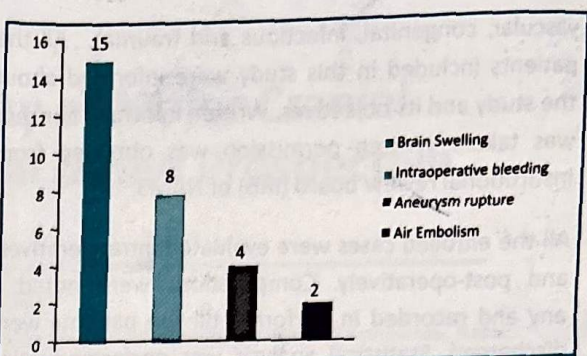


Figure 4: Common intraoperative complications

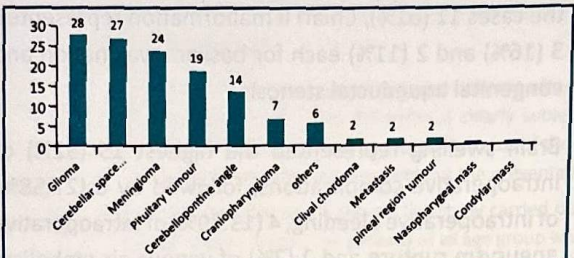


Figure 3: Distribution of cranial surgery for tumor

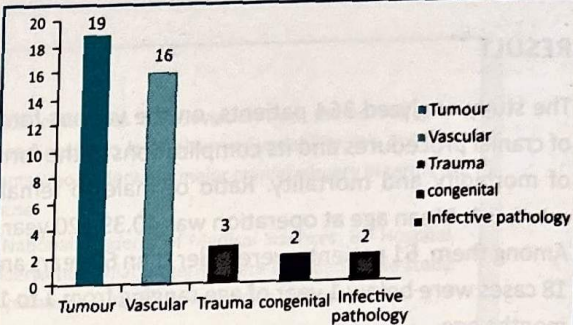


Figure 5: Mortality in various categorical diseases

Table 1: Distribution of post-operative complications

Neurological complications	Neurological diseases					Total
	Vascular	Tumor	Congenital	Infective	Trauma	
Pulmonary complications	19	22	4	3	2	50
Seizures	7	5	2	3	3	20
DI (Diabetic insipidus)	2	5	0	2	1	10
Cerebral salt wasting	0	1	0	2	0	3
Cerebral infarction	6	4	0	2	0	12
EDH (Epidural hematoma)	3	4	0	0	1	8
SDH (subdural hematoma)	2	1	0	0	0	3
CSF leakage	0	2	4	0	0	6
VP shunt blockage	0	2	4	0	0	6
DVT (deep vein thrombosis)	2	1	0	0	0	3
UTI (urinary tract infection)	3	4	0	1	2	10
Suture necrosis	3	4	0	0	3	10
Hydrocephalus	1	3	1	1	1	7
Pseudomeningocele	2	5	0	0	0	7
Subdural abscess	0	0	2	0	0	2
Wound dehiscence	1	2	1	0	0	4
Cavity hematoma	1	2	0	0	0	3
Neurologic deficit (major)	2	7	0	0	1	10
Total	54	74	18	14	14	174

Table 2: Mortality in aneurysm surgery

Aneurysm surgery (Hunt and Hess grade)	No. of patients	Mortality
I	12	0
II	14	2
III	09	2
IV	04	2
V	05	3

Table 3: Distribution of mortality

Cause of death	No. of patients
Aspiration Pneumonia	15
Cerebral infarction	7
Meningitis	6
Post-operative brain edema/ herniation	5
Sepsis	4
Respiratory failure	3
Malignant hyperthermia	2
Venous air embolism	1
Intracerebral hemorrhage	1

DISCUSSION

Minimizing surgical complications has been a goal in neurosurgery ever since Harvey Cushing began rigorously documenting his own surgical errors more than a century ago.⁵ The nature of diseases for bringing one to cranial neurosurgery are neoplastic, vascular, infectious, trauma and congenital.

Rabadan AT et al looked at surgical complications following malignant brain tumour resection within 30 days in patients of all ages from 19 to 89 years. Age >60 years was not associated with an increase in postoperative complications.⁶ We have similar experience, total number of patients above 60 years is 61 and average age of elderly is 72 years. The number of patients who underwent craniotomy appears to be 27 (7%) with rest of the patient undergoing VP shunt, burr hole and evacuation for chronic subdural hematoma.

Roleston JD et al estimated that surgical complications increased the cost of health care worldwide and directly contributed to patient morbidity and mortality.⁷ In an effort to mitigate morbidity and incentivize best practices, health insurers and the US government linked reimbursement to patient outcomes which showed 14.3% rate of complication in neurological

surgeries. Even with the facility of insurance, the complication occurred were not minimized as most of the complications were preventable. Complications occurred in 43% of cases in our study which is unusually high in comparison to the other studies. This higher rate might be due to constraints of modern neurosurgical equipment, inadequate nursing staff and care, general status of the patients and associated comorbid conditions. This can be mitigated by equipped neurosurgical department with modern neurosurgical tools, providing adequate nursing staff trained with appropriate neuro-nursing care, addressing the proper treatment of comorbid condition prior to surgery and adequate perioperative care.

In our study, 5% of patients had intraoperative complications including 71% of brain swelling and 38% of intraoperative bleeding. This is similar to the findings of the study done by Meixensberger J et al.⁸

Lawrence FM et al described massive intraoperative brain swelling as an infrequent but catastrophic occurrence.⁹ In their initial 11 cases (5 arteriovenous malformations, 4 hematomas, and 2 penetrating injuries), 6 patients made good recovery, 2 were moderately disabled, 1 was severely disabled and 2 were dead. Our study showed good recovery. This showed that malignant intraoperative brain swelling, which once was considered unmanageable, can indeed be managed and that treatment often results in an acceptable outcome.

The rates of postoperative hemorrhage after intracranial surgery vary greatly in the literature, ranging from 0.77–50%.¹⁰ Some studies have defined it as any hemorrhage within the operative bed. Many studies have found that the majority of postoperative hematomas were epidural or intraparenchymal that is comparable to our study of 38% intraoperative bleeding, epidural hematoma being the most common form.

The risk of developing a venous air embolism exists for all kinds of neurosurgical procedures; however, its incidence is higher for procedures done in a sitting or semi sitting position.^{11,12}

Air embolism occurs in the presence of a pressure differential at two different sites of the venous system, which in turn causes a negative pressure or sub-atmospheric gradient between the right atrium

and the cranial venous sinuses. When the venous system of the central nervous system is exposed to environmental pressure and there is a difference of at least 5 cm of H_2O between the two sites, there will be air inflow.¹³ Venous air embolism appears to be rare but dreadful intraoperative complication which usually occurs in surgeries in sitting and semi-sitting position, in our setting two patients had intraoperative venous air embolism.

Major complications after intracranial surgery occurs in 13–27% of patients.¹⁴ These complications may be neurologic, haemodynamic, metabolic or respiratory in nature. Major neurologic complications include postoperative haematomas, cerebral oedema and seizures, and should be differentiated from minor events of post-operative nausea and vomiting (PONV), pain and hyperglycaemia. However, there is a possible relationship between events.

Most commonly observed post-operative neurological complications in the elective skull surgeries by Laurent L et al were cerebral vasospasms, refractory seizures, hemiparesis and intraparenchymal hematoma.¹⁵ Other post-operative complications of elective neurosurgeries include nausea and vomiting, hypotension, respiratory distress, and surgical site infection. Intracranial hypertension, motor deficits, recurrent subdural hematoma, intraparenchymal hemorrhage, vasospasms, and seizures are also reported in non elective surgeries.

Post-operative pulmonary complications (PPCs) predominantly include pneumonia, bronchitis, atelectasis, deterioration of lung disease and respiratory failure.^{16,17} PPCs can lead to significant increase in the intensive care unit (ICU)/hospital stay, morbidity and mortality. In the study by Bharati SJ et al, 137 (14.3%) patients developed PPCs in the postoperative period.¹⁸ In our study almost 28% of the cases had respiratory complications, high compared to other studies. Our patients had higher postoperative seizure (11%) compared to international figure of 2%.

A higher grade of Hunt and Hess predicts a poor outcome and lower likelihood of survival.¹⁹ In the study of Lantigua H et al, in-hospital mortality was 18% (216/1200): 3% for Hunt-Hess grade 1 or 2, 9% for grade 3, 24% for grade 4, and 71% for grade 5.²⁰

In our study, the mortality rate was 20.45%(9/44). Grade I had no mortality. Grade II, III, IV had 22% each respectively and grade V had 34% mortality.

Complications from specific procedures are also reported in different literatures reports, such as CSF complications.^{21,22} However there are few if any reports on overall service specific complications. Studies from developed world has reported complications rate as high as 16% resulting in significant morbidity and in more than 50% of the adverse events second surgery was required.²³ Rolston JD et al reported complications occurring in 14.3% of neurosurgical cases.⁷ They found that cranial cases were 2.6 times more likely to have complications than spine cases and the most frequent complications were bleeding requiring transfusion and reoperation within 30 days of the initial operations.

Adverse events are commonly taken as a yard stick to measure the quality of care. Complications not only increase the cost of health care but also directly contribute to major morbidity and mortality. As the cost of health care is increasing day by day, different stakeholders are now focusing on increasing the quality of care by minimizing the complications.

CONCLUSION

Post-operative complications in neurosurgical patients are still high. Pulmonary complications appear as the commonest related to morbidity and mortality. Many of these complications could be reduced if standardized protocol and guidelines based ICU and post-operative care are implemented. Despite several efforts to reduce the morbidity and mortality, pulmonary complications appeared as major factor directly promoting risk and mortality. However most of the complications occurred in our setting are preventable.

LIMITATION

The study population was hospital based and therefore sample size might not be representative for entire population. The study was carried out in a small sample for a short duration of time. Thus these finding may not be applicable to all.

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