Original Article

Perioperative care practices and outcomes of intracranial neurosurgery: Experience at a dedicated neurosciences hospital in a developing country

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Abstract

Background and Aims: Understanding of perioperative care practices and early postoperative outcomes helps minimize potentially preventable perioperative complications while supporting systemic and neurological well-being. The objective of this prospective study was to evaluate the perioperative care practices and early postoperative outcomes of cranial neurosurgery at a high-volume tertiary care neurosciences hospital in India. We also aimed to see if the care elements differed depending on the surgical approach. We hypothesized that care elements and outcomes are likely to be different between major surgical approaches.
Material and Methods: This was a prospective observational study of consecutive adult neurosurgical patients who underwent elective surgeries for intracranial pathologies over a period of six months from October 2020 to March 2021 at a tertiary care neurosciences center in India. Perioperative data about intraoperative care elements and early postoperative outcomes till the third day after surgery were collected.
Results: Incidence of blood loss >1 L was significantly ($P = 0.07$) higher after infratentorial surgery (26%, $N = 17$). Incidence of intraoperative and postoperative desaturation was more after transnasal surgery (6%, $N = 2$, $P = 0.002$, and 9%, $N = 3$, $P = 0.01$, respectively).
Conclusion: This study informs the early perioperative care practices of neurosurgical patients from a dedicated neurosciences hospital in a developing world. We observed that transnasal surgery was associated with more perioperative adverse events and slower convalescence compared to supra- and infratentorial surgeries despite being a considerably less invasive surgery.

Keywords: Postoperative, intracranial surgery, perioperative care practices

Introduction

Knowledge on institutional perioperative care practices and postoperative outcomes in patients undergoing intracranial neurosurgeries as a whole is not well-documented in literature. Understanding perioperative care practices and early postoperative outcomes help in planning care services and costs, aids in counselling of patients and family, guides resource allocation, and helps minimize potentially preventable perioperative complications while supporting systemic and neurological well-being.[1] Early postoperative care begins once the patient leaves the operating room till about 72 h after surgery. While complications can occur throughout the

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postoperative hospital period, the highest incidence is seen during this three-day period.[2]

Planning of perioperative care begins at the time of pre-anesthetic evaluation.[3] Postoperative morbidity is mostly attributable to preoperative diagnosis, intraoperative surgical or anesthetic complications, and postoperative needs such as nutrition, mobilization, and pain management.[4–6] While preoperative factors such as age, gender, and diagnosis are non-modifiable factors of clinical outcomes, intraoperative factors, such as choice of anesthesia and analgesia techniques, blood loss and transfusion patterns, and hemodynamic changes, also influence the postoperative course.[7–9] These components may vary between different hospitals, more so between developed and developing countries. Similarly, early postoperative care elements such as tracheal extubation practices, pain relief measures, initiation of oral feeding, mobilization, and discharge time after cranial surgery also have a bearing on outcome.[10–12] These care elements are also not well-defined and are dependent on local institutional practices. Knowledge on care elements and practices helps in comparing clinical outcomes between similarly placed hospitals and facilitates quality improvement.

The objective of this prospective study was to evaluate the perioperative care practices and early postoperative outcomes of cranial neurosurgery at a high-volume tertiary care neurosciences hospital in India. We also aimed to see if the care elements differed depending on the surgical approach. We hypothesized that care elements and outcomes were likely to be different between major surgical approaches.

Material and Methods

This was a prospective observational study of consecutive adult neurosurgical patients who underwent elective surgeries for intracranial pathologies over a period of six months from October 2020 to March 2021 at the National Institute of Mental Health and Neurosciences, Bengaluru, India. Patients undergoing extracranial surgery and having a Glasgow coma scale (GCS) score <15 were excluded from the study. Patients were recruited into this study after receiving their written informed consent and approval from the institutional ethics committee.

The perioperative data were collected by a research assistant and stored in digital format (Microsoft Excel worksheet). We collected information about intraoperative care elements and early postoperative outcomes till the third day after surgery. The data during the intraoperative period included duration of surgery and anesthesia, surgical approach, anesthesia and analgesia techniques, hemodynamic instability (change in mean blood pressure [MBP] by 20% from baseline for ≥5 minutes) and desaturation (peripheral oxygen saturation [SpO_2] <92% for ≥5 minutes), and blood loss >1 L. The data collected in the post-anesthesia care unit (PACU) included pain using the numerical rating scale (NRS) score, occurrence of postoperative nausea and vomiting (PONV), and hypo- or hypertension and oxygen desaturation. We also collected data regarding tracheal extubation at the end of the surgery and transfer of patient to the neurointensive care unit (NICU). For early postoperative period, we collected data regarding postoperative pain, reintubation rates, postoperative delirium (POD), need for surgical re-exploration, continuation of steroids, and discharge from the hospital. We also captured the timing of removal of bladder catheter, initiation of oral feeds, and ambulation after surgery. For the purpose of descriptive analysis, the patients were divided into three groups depending on the surgical approach to the intracranial pathology: supratentorial surgery (group ST), infratentorial surgery (group IT), and transnasal surgery (group TN). The care elements were compared for three time periods, namely, intraoperative period, PACU period, and early postoperative period.

Statistical analyses

Since this was an exploratory study regarding perioperative care practices, no formal sample size was determined. Data were analyzed using Microsoft Excel version 2010. Important perioperative care elements were tested for association with type of surgery using the Chi-squared test. Multiple logistic regression analysis was not considered due to the small sample size in individual study groups. Interval/ordinal scale variables are presented as mean and standard deviations, while nominal variables are presented as frequency and percentages. $P < 0.05$ was taken as the level for statistical significance.

Results

We screened 620 patients for eligibility for recruitment into our study. The flow of the patients into the study is shown in Figure 1. After excluding 211 patients, we report the data of 323 patients. The mean age of the patients in this study was 42 ± 14 years and the mean body mass index (BMI) was 27 ± 24 kg/m^2. There were 158 (48.9%) males and the majority of the patients (248/323, 76.8%) were from rural areas. Most of the patients (267/323, 82.7%) belonged to the American Society of Anesthesiologists (ASA) physical status class 1 or 2 while the remaining 56 (17.3%) belonged to ASA class 3. Most of our patients (226/323, 70%) underwent supratentorial surgery, 65 (20%) underwent infratentorial surgery, and 32 (10%) patients underwent pituitary surgery via the transnasal approach. The intraoperative details are described in Table 1, the PACU details in Table 2, and the early postoperative details are described in Table 3.

The common elements with regards to anesthesia and analgesia included induction of anesthesia with thiopentone and local anesthetic infiltration (lignocaine 1%, bupivacaine 0.25%, or their combination) at incision site before surgery.

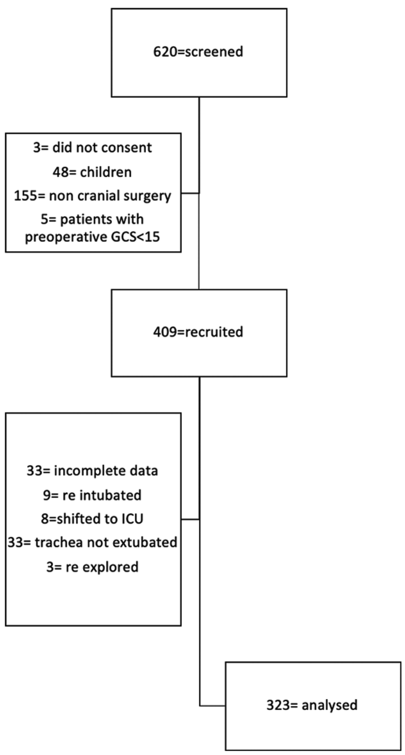

Figure 1: Flow of patients into the study

Fentanyl or morphine were used as the intraoperative opioid analgesic. Ondansetron was administered for PONV prophylaxis at the beginning of surgical closure. Reversal of neuromuscular blockade at the end of surgery was with glycopyrrolate and neostigmine. Postoperative analgesia was opioid-free with a fixed dose of intravenous diclofenac. Paracetamol and/or tramadol were used as rescue analgesics in all the patients. Airway was secured with an endotracheal tube for all patients undergoing craniotomies under general anesthesia, whereas awake craniotomies were performed without artificial airway using dexmedetomidine and scalp block combination, and fentanyl supplementation when needed. Balanced technique was used for maintenance of general anesthesia in all patients except for those requiring intraoperative neuromonitoring (IONM). In these patients, a propofol-based intravenous anesthetic technique was used. Neuromuscular blocking agents were not administered after the intubating dose when IONM was required.

Some of the important findings of our study are detailed in Tables 1, 2, and 3. The duration of surgery was more than four hours in about one-third of patients undergoing infratentorial surgeries ($P = 0.09$). Intraoperative maintenance of anesthesia with propofol infusion was mostly done in group IT (32%, $N = 21$, $P = 0.002$), and dexmedetomidine infusion was mostly used in group TN (34%, $N = 11$, $P = 0.02$). Intraoperative opioid consumption was similar for all the three groups ($P = 0.26$) despite the use of scalp block for preemptive analgesia for (ST > IT) craniotomies (73%, $N = 165$, $P < 0.001$). Incidence of blood loss >1 L was significantly ($P = 0.07$) higher in group IT (26%, $N = 17$) and least in group TN (6%, $N = 2$). Incidence of intraoperative

Table 1: Intraoperative characteristics of patients undergoing supratentorial (ST), infratentorial (IT), and transnasal (TN) neurosurgeries

Parameter	Group ST (*n*=226)	Group IT (*n*=65)	Group TN (*n*=32)	*P*
Duration of surgery >4 h	60 (27%)	24 (37%)	5 (16%)	0.09
Duration of anesthesia >4 h	77 (34%)	26 (40%)	11 (34%)	0.67
Anesthesia Technique				0.33
General anesthesia	221 (98%)	65 (100%)	32 (100%)	
Awake/sedation	5 (2%)	0 (0%)	0 (0%)	
Inhalation Anesthesia Maintenance				
Sevoflurane	209 (92%)	60 (92%)	30 (94%)	0.96
Desflurane	13 (6%)	4 (6%)	2 (6%)	0.98
Isoflurane	4 (2%)	1 (1.5%)	0 (0%)	0.74
>4 minimum alveolar concentration hours	40 (18%)	12 (18%)	6 (19%)	0.98
Intravenous Anesthesia Maintenance				
Propofol	42 (19%)	21 (32%)	1 (3%)	0.002
Dexmedetomidine	33 (15%)	12 (18%)	11 (34%)	0.02
Hemodynamic instability	32 (14%)	9 (14%)	4 (13%)	0.90
Blood loss >1 L	47 (21%)	17 (26%)	2 (6%)	0.07
Morphine equivalence dose (mg)	12±6	13±6	11±5	0.26
Scalp block	165 (73%)	43 (66%)	0 (0%)	<0.001
Desaturation (<92% for >4 min)	0 (0%)	1 (1.5%)	2 (6%)	0.002

Table 2: Events in the post-anesthesia care unit in patients undergoing supratentorial (ST), infratentorial (IT), and transnasal (TN) neurosurgeries

Parameter	Group ST (*n*=226)	Group IT (*n*=65)	Group TN (*n*=32)	*P*
NRS pain score >4	29 (13%)	5 (8%)	6 (19%)	0.27
PONV	34 (15%)	8 (12%)	6 (19%)	0.69
Hypotension (MAP <30%)	5 (2%)	0 (0%)	2 (6%)	0.13
Hypertension (MAP >30%)	29 (13%)	11 (17%)	6 (19%)	0.01
Desaturation (SpO_2 <92%)	3 (1%)	1 (1.5%)	3 (9%)	0.01
Trachea not extubated, shifted to ICU	22 (10%)	11 (17%)	1 (3%)	0.08
Trachea extubated, shifted to ICU	3 (1%)	3 (5%)	2 (6%)	0.11

NRS=Numerical rating scale; PONV=Postoperative nausea and vomiting; MAP=Mean arterial pressure; SpO_2=Oxygen saturation; ICU=Intensive care unit

Table 3: Early postoperative (<72 h) events in patients undergoing supratentorial (ST), infratentorial (IT), and transnasal (TN) neurosurgeries

Parameter	Group ST (*n*=226)	Group IT (*n*=65)	Group TN (*n*=32)	*P*
Reintubation	5 (2%)	3 (5%)	0 (0%)	0.34
Re-exploration	1 (0.4%)	0 (0%)	1 (3%)	0.15
Postoperative delirium	57 (25%)	5 (8%)	3 (9%)	0.002
Postoperative Steroid Use				
POD1	143 (63%)	49 (75%)	26 (81%)	0.07
POD2	122 (54%)	46 (70%)	24 (75%)	0.003
POD3	75 (33%)	32 (49%)	22 (68%)	0.001
Bladder Catheter *in situ*				
POD1	109 (48%)	35 (54%)	24 (75%)	0.01
POD2	59 (26%)	12 (18%)	16 (50%)	0.01
POD3	26 (11%)	7 (11%)	6 (19%)	0.46
Non-Initiation of Oral Feeds				
POD1	75 (33%)	25 (38%)	16 (50%)	0.15
POD2	17 (8%)	2 (3%)	5 (16%)	0.08
POD3	2 (0.9%)	2 (3%)	1 (3%)	0.33
Not Ambulated				
POD1	87 (38%)	30 (46%)	18 (56%)	0.12
POD2	41 (18%)	7 (11%)	8 (25%)	0.18
POD3	19 (8%)	4 (6%)	4 (13%)	0.56
NRS Pain Score >4				
POD1	38 (17%)	11 (17%)	7 (22%)	0.77
POD2	16 (7%)	4 (6%)	3 (9%)	0.84
POD3	4 (2%)	3 (5%)	1 (3%)	0.41
Discharged from Hospital				
POD1	2 (0.9%)	0 (0%)	0 (0%)	0.6
POD2	18 (8%)	0 (0%)	0 (0%)	0.01
POD3	27 (12%)	11 (17%)	1 (3%)	0.14

POD=Postoperative day; NRS=Numerical rating scale

desaturation was more in group TN (6%, $N = 2$, $P = 0.002$). In the PACU, the incidence of hypertension (MBP >20% baseline) was higher in group TN (19%, $N = 6$, $P = 0.01$). Similarly, incidence of postoperative desaturation was higher in group TN (9%, $N = 3$, $P = 0.01$). The trachea was not extubated after surgery in 17%, 10%, and 3% of patients in groups IT, ST, and TN, respectively ($P = 0.08$). Incidence of POD was 25%, 8%, and 9% in groups ST, IT, and TN, respectively ($P = 0.002$). During the first three postoperative days, steroid prescription was significantly higher in patients in group TN. However, the indication to use postoperative steroids was different in group TN compared to other groups. Similarly, more patients in group TN had bladder catheter *in situ* during the first two postoperative days ($P = 0.01$). However, there was no significant difference between the groups on the third day. No patients were discharged from the hospital on the first two postoperative days in groups IT and TN. A significantly higher number of patients were discharged on the second postoperative day in group ST ($P = 0.01$). Patients in the TN group had more adverse events (significant pain, PONV, hypertension, desaturation) in the PACU compared to the other groups; however, this was not statistically significant. Similarly, more patients in this group had delayed initiation of oral feeds, delayed removal of urinary catheter, longer time for ambulation, and delayed discharge from hospital, but these differences were not statistically significant.

Discussion

This study informs the early perioperative care practices of neurosurgical patients at a dedicated neurosciences hospital in a developing country. Among the three major approaches to cranial surgery, we observed that transnasal surgery was associated with more perioperative adverse events and slower convalescence compared to supra- and infratentorial surgeries despite being a considerably less invasive surgery.

Previous studies have reported varied time durations for neurosurgery: from 30 minutes to 11 hours.[13] In this study, 28% ($N = 89$) of surgeries lasted longer than four hours. Overall, the duration of surgery was longer for infratentorial surgeries (37% of patients) with a proportionate increase in duration of anesthesia exposure. Prolonged duration of surgery and anesthesia are known to be associated with POD.[13] However, in our study, we observed that the POD was least among patients who underwent infratentorial surgery. It is likely that direct cortical handling in patients undergoing supratentorial surgery may have contributed to an increased incidence of POD in those patients.

IONM is routinely used for infratentorial neurosurgical procedures, and propofol is the most common anesthetic component of intravenous anesthesia technique.[14] We too observed that propofol was mostly used for infratentorial surgery to facilitate IONM. Intraoperative dexmedetomidine has been shown to maintain intraoperative hemodynamic stability.[15] In our study, dexmedetomidine was used in 34% of patients undergoing transnasal surgery to maintain hemodynamic stability. Postoperative pain is considered to be more intense after infratentorial surgery than supratentorial surgery.[16] In this study, there was no difference in postoperative pain or opioid consumption between supratentorial or infratentorial surgery. Lack of sufficient sample size in each group may be one of the reasons for this absence. Significant blood loss occurs in up to 45% of patients undergoing neurosurgery and the incidence is similar for supratentorial and infratentorial skull base surgery.[17,18] In our study, significant blood loss—defined as blood loss >1 L—was more (26%, $P = 0.07$) in patients undergoing infratentorial surgery compared to the other two groups. The incidence of obstructive sleep apnea in patients undergoing transnasal surgery is about 16% and perioperative oxygen desaturation has been reported in this population.[18] Two of our patients had oxygen desaturation immediately after tracheal extubation and three patients desaturated in the PACU. There is very limited information about the incidence of perioperative hypertension in patients undergoing transnasal endoscopic pituitary surgery. However, it is a well-known complication, and permissive hypotension has been described in literature to mitigate this.[18] In our study, 19% of the patients undergoing transnasal surgery had hypertensive episodes in the PACU. The incidence of delayed tracheal extubation after neurosurgery is as high as 49.8%. In contrast, we observed an 11% incidence of delayed extubation in our patients, with maximum incidence after infratentorial surgery. The incidence of POD in the ICU after elective intracranial surgery has been described as 19%.[19,20] In the present study, the incidence of POD was similar at 20% despite none of the patients being admitted to the ICU. Maximum incidence of POD occurred after supratentorial surgery (25%).

There is no previous literature to compare our postoperative care elements among the neurosurgical population. In the present study, patients in group TN had more adverse events (pain, PONV, hypertension, desaturation) in the PACU compared to other groups; however, these were not statistically significant.

A higher number of patients in this group also had delayed initiation of oral feeds, delayed removal of urinary catheter, longer time for ambulation, and delayed discharge from hospital, but none were statistically significant. Studying postoperative care elements of patients undergoing transnasal surgery individually is likely to throw more light on the reasons for these observations and may guide changes in existing clinical practices.

To the best of our knowledge, this is the first study that describes the perioperative care elements in neurosurgical patients as a single entity and compares them based on surgical approaches. Information on perioperative care elements would be critical for resource-limited healthcare settings of developing countries. The major limitation of this study was the lack of sufficient patients in groups IT and TN. This was largely due to the patient distribution and diagnosis pattern in our hospital during the study period. A larger sample in each group for comparing care elements is required to preemptively predict perioperative complications and postoperative course in neurosurgical population. Secondly, influence of intraoperative patient positioning like prone position in group IT was not taken into analysis. The third limitation of this study was the potential clinician bias for various care elements between different surgical units for the same surgical approach to neurosurgical pathology which might have confounded our results. Uniformity in perioperative practices among all neurosurgeons would have enabled a better comparison between different surgical approaches. Fourth, our perioperative practices might be different from that of the developed world, and hence, there could be limitation of generalizability. However, our study serves as a ready source of data for any future comparisons of perioperative care elements and in turn, outcomes in neurosurgical population between the developing and the developed world.

Conclusion

Our study demonstrated that perioperative care elements are different for different surgical approaches to neurosurgical pathologies. We also observed differences in perioperative outcomes with more adverse events for minimally invasive transnasal surgeries compared to more invasive supra- and infratentorial surgeries. Large comparative studies, especially between developing and developed countries, are needed to examine the impact of differences in perioperative practices on the perioperative outcomes in the neurosurgical population.

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Conflicts of interest
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