Evaluating predictors of successful postoperative day 1 discharge following posterior fossa tumor resection

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Abstract

INTRODUCTION: Current trends in surgical neuro-oncology have shown that early discharges are both safe and feasible with shorter lengths of stay (LOS) associated with fewer thromboembolic complications, less hospital-acquired infections, reduced costs, and greater patient satisfaction. Traditionally, infratentorial tumor resections have been associated with longer LOS and limited data exists evaluating predictors of early discharge in these patients. The objective was to assess patients undergoing posterior fossa craniotomies for tumor resection and identify variables associated with a postoperative day 1 (POD1) discharge and determine any differences in outcomes and readmission rates.

METHODS: A retrospective review of posterior fossa craniotomies for tumor resection at our institution was performed from 2011 to 2020. Laser ablations, craniotomies for non-tumoral pathologies, and biopsies were excluded. Complete demographic, clinical, surgical and postoperative data was collected for each patient.

RESULTS: 173 patients were identified and 25 (14.5%) were discharged on POD1. Median length of stay was 6 days. The POD1 discharges had significantly better preoperative Karnofsky performance scores ($p<0.001$) and modified Rankin scores ($p=0.002$) and less frequently presented emergently ($p=0.006$) or with preoperative neurologic deficits ($p=0.021$). No statistically significant difference in 30-day readmissions and rates of PE, UTI, and DVT were found between the POD1 discharge cohort and those discharged later. Univariate logistic regression identified better preoperative functional status, elective admission, and lack of preoperative hydrocephalus as independent predictors of POD1 discharge however only the latter remained significant in the multivariable model ($p=0.001$).

CONCLUSIONS: Discharging patients on POD1 is feasible following posterior fossa tumor resections and does not introduce any significant undue risk or result in higher readmissions. Although we found that the only independent predictor for a longer LOS was preoperative hydrocephalus, larger, prospective studies are needed to confirm these findings.

Introduction

Although studies continue to demonstrate the advantages of reduced postsurgical length of stay (LOS), [1-8] the complexity of surgical neuro-oncology has traditionally resulted in lengthier hospital admissions for these patients. [9] [10-13] This is especially true for posterior fossa tumors as historically many believed that infratentorial interventions conferred inherently higher risk than their supratentorial counterparts and thus required longer periods of postoperative monitoring. [14-21] [22-24] [25, 26] As such, we analyzed all patients who underwent resection of a posterior fossa tumor resection by a single, high-volume surgical neuro-oncologist to determine predictors of successful postoperative day (POD) 1 discharge.

Methods

Study Population

Following Institutional Review Board approval, a retrospective analysis of all posterior fossa brain tumor resections performed at the institution from September 2011 to July 2020 was performed. Supratentorial craniotomies, as well as infratentorial biopsies, laser ablations, and craniotomies for non-tumoral pathologies were excluded. Complete demographic, radiographic, and clinical data were collected for each patient. POD1 discharges were compared to the remainder of the cohort discharged on $\geq$ POD2 in an effort to determine predictors of early discharge in this patient population.

Outcome Measures

The modified Frailty Index (mFI) is a previously validated scoring system to determine the extent of preoperative patient comorbidities. It was calculated for each patient in this cohort as prior studies have demonstrated that higher mFIs are associated with longer and more complicated postoperative hospital stays [27, 28]. Pre- and postoperative Karnofsky Performance Scores (KPS) and modified Rankin Scales (mRS) were calculated for each patient and utilized as a surrogate for perioperative neurologic function in order to identify any differences in functional status within the cohort. [29, 30] Other perioperative variables, including tumor diameter, previous surgery/radiation and 30-day readmission rates, were also recorded and compared across the cohort.

Statistical Analysis

Descriptive statistics comparing patients discharged on POD1 with patients discharged later were analyzed using *t* tests, Fisher exact, and χ^2 tests for continuous and categorical variables, respectively. Univariate analysis was used to examine the associations between the preoperative predictors and successful discharge on POD1. Multivariate logistic regression models were constructed to assess the association of the combined predictors with successful discharge on POD1. Odds ratios (ORs) and 95% confidence intervals were calculated. Statistical associations were considered significant for $P < 0.05$. Data was analyzed using IBM SPSS, (Armonk, New York, USA).

Results

Overall Cohort Characteristics

173 patients were included in this study (Figure 1). Mean length of stay (LOS) was 7.85 days (median, 6 days, interquartile range, 3-9) and 14.5% were discharged on POD1. Demographic data is displayed in Table 1. Mean age of the cohort was 56.4 ± 15.7 years (range 18-82) and 37.0% of patients were male with no statistically significant difference in age or gender seen between the POD1 discharges and those discharged after POD1. Most of the patients were admitted electively (74.6%). However, emergency admissions, lower preoperative KPS/mRS, and preoperative neurologic deficits were more prevalent in the subgroup of patients discharged after POD1 ($p=0.006$, $p<0.001$, $p=0.002$, and $p=0.021$, respectively). Preoperative KPS and mRS were also highly correlated with one another (Pearson coefficient -0.890,

p<0.001). Tumor pathology is displayed in Figure 2 and did not vary significantly based on POD discharge.

Table 1

Preoperative patient characteristics for patients discharged on POD1 and those with later discharge. POD1, postoperative day 1; KPS, Karnofsky performance status; mRS, modified Rankin score; mFI, modified frailty index; BMI, body mass index. Data is represented as n (%) or mean $\pm$ standard error of the mean.

Characteristic	POD1 Discharge (n=25)	Later Discharge (n=148)	Total (n=173)
Age (years)	60.6 $\pm$ 3.0	55.7 $\pm$ 1.3	56.4 $\pm$ 1.2
Male gender	9 (36.0%)	55 (37.2%)	64 (37%)
Current smoker	4 (16.0%)	9 (6.1%)	13 (7.5%)
Former smoker	7 (28.0%)	51 (34.5%)	58 (33.5%)
Preoperative Seizure	1 (4.0%)	7 (4.7%)	8 (4.6%)
Preoperative KPS score	87.2 $\pm$ 1.7	76.6 $\pm$ 1.2	78.15 $\pm$ 1.1
Preoperative mRS score	1.12 $\pm$ 0.1	1.82 $\pm$ 0.1	1.72 $\pm$ 0.1
Preoperative mFI score	0.08 $\pm$ 0.02	0.09 $\pm$ 0.01	0.09 $\pm$ 0.01
Preoperative neurologic deficit	7 (28.0%)	78 (53.1%)	85 (49.4%)
Emergency admission	1 (4.0%)	43 (29.1%)	44 (25.4%)
Previous craniotomy	3 (12.0%)	15 (10.1%)	18 (10.4%)
Previous radiation	6 (24.0%)	32 (21.6%)	38 (22.0%)
Tumor Max Diameter (cm)	2.85 $\pm$ 0.17	3.24 $\pm$ 0.09	3.18 $\pm$ 0.08
BMI (kg/m ²)	27.6 $\pm$ 1.4	27.6 $\pm$ 0.6	27.6 $\pm$ 0.5

Perioperative Complications and Readmission Rates

To assess the safety of POD1 discharge, perioperative complication rates and 30-day readmission rates were examined. There were no major surgical complications in either subgroup and no differences in perioperative urinary tract infections or thromboembolic events were observed. In the group of patients discharged on POD1, 2 (8.0%) were readmitted within 30 days compared to 24 (16.3%) in the group discharged >POD1 however this difference was not statistically significant. The two readmissions in the POD1 group occurred for reasons unrelated to their cranial surgery (newly diagnosed spinal metastases and chest pain requiring no intervention). In the group discharged >POD1, readmissions occurred because of headaches (20.8%), hydrocephalus (12.5%), cerebrospinal fluid (CSF) leak (12.5%), wound infection (4.2%), and vision changes (4.2%). Of the 3 patients readmitted for hydrocephalus, 2 required

ventriculoperitoneal shunts (VPS) and 1 was managed with steroids. 2 patients with CSF leak were treated with VPS and 1 was treated nonoperatively. The patient with a wound infection required surgical wound revision, and the patient with vision changes presented secondary to diabetic ketoacidosis. The remaining 11 patients in the group discharged >POD1 were readmitted for non-neurosurgical complaints.

Medical Comorbidities

The mFI was utilized to evaluate differences in preoperative comorbidities between the two cohorts. No statistically significant difference was identified for any component of the mFI between patients discharged at POD1 or those discharged >POD1. Furthermore, the mFI only weakly correlated with preoperative KPS and mRS (Pearson coefficient -0.321, $p<0.001$ and 0.300, $p<0.001$, respectively).

Predictors of POD1 Discharge

Univariate analysis was performed to determine those factors predictive of successful POD1 discharge (Table 2). Patients discharged on POD1 were more likely to be electively admitted (likelihood ratio [LR] 9.421, $p=0.002$), have no preoperative neurologic deficits (LR 5.538, $p=0.019$), presented with better preoperative functional status (higher KPS - LR 19.717, $p=0.011$; lower mRS – LR 12.918, $p=0.024$) and were less likely to have preoperative hydrocephalus (LR 40.636, $p<0.001$).

Table 2
Univariate analysis to determine predictors of successful POD1 discharge. KPS, Karnofsky performance status; mRS, modified Rankin score. *Statistically significant.

Variable	Likelihood Ratio	P Value
Patient Characteristic		
Male Gender	0.012	0.911
Age > 65	1.09	0.297
Elective Surgery	9.421	0.002*
No preoperative seizure	0.336	0.845
No previous radiation	0.069	0.792
Previous chemotherapy	0.067	0.796
Previous craniotomy	0.077	0.781
No preoperative deficit	5.538	0.019*
Preoperative KPS score	19.717	0.011*
Preoperative mRS score	12.918	0.024*
Tumor characteristic		
Maximal tumor diameter < 3cm	2.822	0.093
Medical comorbidities		
Asthma	0.049	0.824
Arthritis	0.541	0.462
Smoking (former or current)	2.560	0.278
Coronary artery disease	2.562	0.109
No preoperative hydrocephalus	40.636	<0.001*

Given that patients with preoperative hydrocephalus likely had poorer functional status prior to surgery, we directly compared the group of patients with preoperative hydrocephalus to those without and found that patients with preoperative hydrocephalus had significantly poorer KPS and mRS (Table 3).

Table 3

Comparison of demographic factors between the presence and absence of preoperative hydrocephalus. KPS, Karnofsky performance status; mRS, modified Rankin score; mFI, modified frailty index; BMI, body mass index. Data is represented as n (%) or mean $\pm$ standard error of the mean.

Variable	Preoperative Hydrocephalus (n=89)	No Preoperative Hydrocephalus (n=84)	P-Value
Age	55.42 $\pm$ 1.71	57.43 $\pm$ 1.67	0.400
Elective Surgery	65 (73.0)	64 (76.2)	0.727
Preoperative Deficit	48 (54.5)	37 (44.0)	0.174
Preoperative KPS	74.38 $\pm$ 1.69	82.14 $\pm$ 1.36	<0.001
Preoperative mRS	2.00 $\pm$ 0.12	1.43 $\pm$ 0.10	<0.001
BMI	27.63 $\pm$ 0.78	27.66 $\pm$ 0.68	0.979
mFI	0.91 $\pm$ 0.01	0.90 $\pm$ 0.01	0.946

We then constructed a multivariate logistic regression model to confirm which variables were independent predictors of successful POD1 discharge (Table 4) and found that the absence of preoperative hydrocephalus was the only variable that remained statistically significant (odds ratio [OR], 0.032, $p=0.001$) even when accounting for preoperative KPS/mRS. A second logistic regression model was also performed evaluating only admission type and preoperative hydrocephalus and can be seen in Supplementary Table 1.

Table 3

Multivariate analysis to determine independent predictors of successful POD1. OR, odds ratio; CI, confidence interval; KPS, Karnofsky performance status; mRS, modified Rankin score; AUC, area under the curve; ROC, receiver operator characteristic.

*Statistically significant.

Variable	OR (95% CI)	P-Value
Patient Characteristic		
Elective surgery	7.46 (0.88-62.9)	0.065
No preoperative deficit	0.478 (0.157-1.458)	0.195
Preoperative KPS score	0.926 (0.819-1.047)	0.219
Preoperative mRS score	0.547 (0.122-2.443)	0.429
Operative factors		
No preoperative hydrocephalus	0.032 (0.004-0.249)	0.001*
AUC ROC Curve	0.893	

Discussion

POD1 Patient Selection

Over the years, hospital length of stay (LOS) has consistently been reduced for various surgical procedures, [1-5] with more patients being discharged within 24 hours of their surgery than ever before. [2, 5-8, 31] Although earlier discharges have been shown to minimize hospital costs, exposure to infection, and thromboembolic complications, most posterior fossa craniotomies remain hospitalized for longer periods of time due to concerns over increased periprocedural risk compared to supratentorial surgeries. [14-19] As such, no consensus exists regarding discharge protocols for these surgeries. The goal of this study was to identify preoperative patient and tumor characteristics predictive of POD1 discharge.

In our initial experience with POD1 discharges for cranial tumors, we found that posterior fossa tumor location was an independent predictor of longer LOS [24]. As such, we revised our protocols to allow for early discharge in these patients. After several years, we began accruing a number of patients that were discharged on POD1 following posterior fossa tumor resection and we thought it prudent to evaluate those factors predictive of successful early discharge. Interestingly, we found that, although more patients discharged >POD1 were admitted through the emergency room with worse preoperative neurologic and functional status, the only variable predictive of longer LOS was preoperative hydrocephalus. This finding can be explained by the fact that any patient with obstructive hydrocephalus from a posterior fossa lesion must be monitored after resection for resolution of the ventriculomegaly/symptomatology. Given that this may not occur immediately after surgery, LOS will inherently be prolonged in this subset of patients.

Although preoperative hydrocephalus was also identified as a predictor of later discharge in our previous study, other factors such as tumor laterality/size, mFI, and mRS also contributed to earlier discharge in supratentorial surgeries. These findings were not replicated in our study, although preoperative KPS and mRS were found to be predictive in the univariate models. The fact that both variables had significantly lower scores in the group with preoperative hydrocephalus suggests that performance status may contribute to a higher length of stay in those patients.

POD1 Discharge Protocol

A standard protocol for discharge on POD1 has not yet been outlined for posterior fossa craniotomies. One Australian center has been promoting POD1 discharge regardless of histopathology or tumor location, so long as patients are agreeable and certain criteria are met. [32] The authors reason that the vast majority of complications occur within hours of surgery rather than days, and that complications that necessitated readmission would not have been avoided if the LOS had been prolonged. [32] Previous research has shown that preoperative planning, aseptic technique, microsurgical dissection, adequate wound closure, and use of prophylactic agents can prevent most complications during infratentorial surgeries. [25, 26] Additionally, larger incisions are no longer necessary to access the posterior fossa resulting in less postoperative pain. [33, 34]

The findings in this study should encourage other surgical neuro-oncologists to consider early discharge after posterior fossa tumor resection. Early communication with patients and families about the possibility for POD1 discharge is also critical for discharge preparations. The decision for early discharge must be stringently deliberated because maximizing patient safety is the most essential principle in our practice. [35]

Limitations

The findings reported in this study are limited by the retrospective nature of our data acquisition. Given that the data is from a single surgeon the generalizability of our findings is also limited. The small sample size of the group discharged on POD1 restricted the statistical power to assert definitive conclusions and the ability to utilize more variables for the binary logistic regression model. In addition, there were several variables which were not analyzed that may effect the results, such as operative time under general anesthesia, which cannot be easily obtained retrospectively.

Conclusion

This study shows that POD1 discharge is safe and not associated with any undue risk to patients undergoing posterior fossa tumor resection. No 30-day neurosurgical readmissions occurred in the POD1 discharge cohort and lack of preoperative hydrocephalus was the only significant independent predictor for early discharge. Although not significant in the multivariate model, better functional status and the absence of a preoperative neurologic deficit was observed more frequently in the POD1 cohort. Further prospective studies with larger sample sizes are needed to verify the factors most predictive for POD1 discharge in patients undergoing posterior fossa craniotomy for tumor resection.

Declarations

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Conflicts of interest

The authors have no relevant financial or non-financial interest to disclose.

Author contributions

All authors contributed to the study conception and design. Material preparation and data collection were performed by Hunter King, Melissa Hernandez, and Mynor Mendez Valdez. Analysis was performed by Hunter King. The first draft of the manuscript was written by Hunter King, Alexis Morell, and Evan Luther. All authors read and approved the final manuscript.

Data availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval

This is an observational study. The study was approved by the IRB of the University of Miami (Study Number: 20160437)

Consent to publish

Not applicable

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Figures

Figure 1

Study Overview. Figure made with BioRender.com

Figure 2

Comparison of tumor pathology by percentage and POD1 discharge.

Supplementary Files

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