Same-day discharge after craniotomy for supratentorial tumour surgery: a retrospective observational single-centre study

Congé le jour même après craniotomie pour chirurgie sur tumeur sus-tentorielle: étude observationnelle rétrospective d'un centre hospitalier

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Abstract

Purpose Enhanced Recovery After Surgery is a multimodal perioperative care pathway designed to achieve early discharge in patients undergoing major surgery. Recent advances in neurosurgery allow for shorter duration of anesthesia and surgery, faster recovery, and earlier discharge from hospital. The purpose of this retrospective observational study was to assess the incidence of early discharge from hospital in patients undergoing craniotomy for supratentorial brain tumours as well as to explore the associated perioperative factors, anesthesia techniques, and complications.

Methods The medical records of all patients who underwent craniotomy (less than four-hour duration) for supratentorial tumour over a five-year period were retrospectively reviewed. The data analyzed included the postoperative discharge destination, type of anesthesia—i.e., general anesthesia (GA) vs awake craniotomy (AC), and the incidence of adverse events.

Results Data from 329 patients [mean (SD) age 48 (12) yr; 164 male, 165 female] were analyzed, including 198 (AC, $n = 157$; GA, $n = 41$) patients who were preoperatively

scheduled for same-day discharge. Successful same-day discharge occurred in 175/198 (88.4%) of these patients (AC, $n = 139$; GA, $n = 36$). Five (2.9%) of the 175 patients (4 AC, 1 GA) with same-day discharge required readmission to hospital within the first 12 hr after discharge. Six (1.8%) of the 329 total patients had a documented postoperative intracranial bleed, but none occurred after initial discharge from hospital.

Conclusion Same-day discharge from hospital is possible in carefully selected patients after both GA and AC for supratentorial tumour surgery.

Résumé

Objectif La Récupération rapide après chirurgie est une voie multimodale de soins périopératoires conçue pour permettre un congé rapide des patients subissant une chirurgie majeure. Des progrès récents en neurochirurgie permettent une réduction de la durée de l'anesthésie et de la chirurgie, une récupération plus rapide et une sortie plus précoce de l'hôpital. L'objectif de cette étude observationnelle rétrospective était d'évaluer l'incidence d'un congé précoce de l'hôpital chez des patients subissant une craniotomie pour tumeur cérébrale sus-tentorielle et d'explorer les facteurs périopératoires, les techniques d'anesthésie ainsi que les complications associées.

Méthodes Les dossiers médicaux de tous les patients ayant subi une craniotomie (d'une durée inférieure à quatre heures) pour tumeur sus-tentorielle au cours d'une période de cinq ans ont été étudiés de manière rétrospective. Les données analysées incluaient la destination après le congé post opératoire, le type d'anesthésie (c'est-à-dire, anesthésie générale [AG] contre craniotomie éveillée [CÉ]) et l'incidence des événements néfastes ou indésirables.

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Résultats Les données de 329 patients (âge moyen [ET]: 48 [12] ans; 164 hommes et 165 femmes) ont été analysées, incluant 198 (CÉ, $n = 157$; AG, $n = 41$) patients pour lesquels le congé le même jour avait été prévu en préopératoire. Le congé a été possible le même jour pour 175/198 (88,4 %) de ces patients (CÉ, $n = 139$; AG, $n = 36$). Cinq (2,9 %) patients sur 175 (4 CÉ, 1 AG) ayant reçu leur congé le même jour ont dû être réhospitalisés dans les 12 heures suivant le congé. Six (1,8 %) patients sur l'ensemble des 329 patients ont eu un saignement intracrânien postopératoire documenté, mais aucun cas n'a eu lieu après le congé de l'hôpital.

Conclusion Un congé de l'hôpital le même jour est possible chez des patients soigneusement sélectionnés après AG et CÉ pour chirurgie tumorale sus-tentorielle.

Enhanced Recovery after Surgery (ERAS) is a multimodal perioperative care pathway designed to achieve an improved functional capacity and early discharge in patients undergoing major surgery.¹ Enhanced Recovery after Surgery represents a paradigm shift in perioperative care where traditional practices were re-examined and replaced with evidence-based best practices that cover all aspects of patient care through the surgical process.² Though pioneered for colorectal surgery, ERAS is gaining momentum in other major surgeries, such as pelvic and orthopedic procedures.^{3,4} Traditionally, neurosurgery is a resource-intensive surgical specialty where surgery for a brain tumour often involves a large craniotomy with invasive intraoperative monitoring and frequent admission to the postoperative intensive care unit (ICU).^{5,6} The advent of intraoperative neuronavigation has helped in planning a more precise surgical approach to the targeted lesion and thus the use of a minimally invasive craniotomy.⁷ A smaller craniotomy flap allows for a shorter duration of anesthesia and surgery, faster recovery, and less need for postoperative admission to the ICU.⁸ As well, an awake craniotomy (AC) can be safely used for many supratentorial tumours, allowing for a potentially faster recovery and discharge from the hospital, as short stay or even as day surgery.⁹⁻¹²

The purpose of this retrospective observational study was to assess the incidence of same-day discharge from hospital in patients undergoing craniotomy for supratentorial brain tumours as well as to explore the associated perioperative factors, anesthesia techniques, and complications.

Methods

After Institutional Research Ethics Board approval (July, 2015), we retrospectively reviewed the medical records of

all patients who underwent craniotomy for supratentorial brain tumour resection (duration of surgery less than four hours) by one surgeon (M.B.) in our institution during the study period from January 1, 2010 to December 31, 2014. We chose a surgical duration (from incision to the end of closure) of less than four hours. This time frame is our criterion for same-day discharge as it allows a minimum of six hours of postoperative observation (Table 1). Exclusion criteria included patients who underwent craniotomy for tumour biopsy with no resection, those with skull or scalp lesions, patients with active unstable medical conditions (e.g., poor control of hypertension, diabetes, or coronary artery disease), and/or those with significant preoperative neurological deficits.

Patient selection and assessment

A single surgeon (M.B.) was responsible for selecting all patients for surgery. The postoperative discharge destination and the type of anesthesia to be administered—i.e., general anesthesia (GA) vs AC, were initially determined by the surgeon but included consultation with the anesthesiologist in the preoperative anesthesia clinic. The same-day discharge status was assigned preoperatively if the patient met the established criteria for day surgery in our hospital (as noted above) and had a suitable caregiver at home.^{13,14} The choice of anesthesia technique (GA or AC) depended on a number of factors, including the tumour size and location, patient cooperation, and the need for our usual institutional standard of intraoperative cortical mapping, which was used to identify the areas of eloquent brain function (i.e., motor and speech areas) in order to avoid neurological injury during resection of the tumour. Nevertheless, AC was also considered in some patients even if cortical mapping was not indicated.^{15,16} All patients underwent routine assessment in the preoperative anesthesia consult clinic where they were prepared and instructed for the chosen anesthesia technique as well as for possible discharge on the same day of surgery.

Surgical management

A single neurosurgeon (M.B.) operated on all patients. A Sugita head frame (Mizuho Medical Co. Ltd, Tokyo, Japan) was used in all patients to allow for fixation of their head to the operating table. A small craniotomy flap was formed in all patients using linear skin incisions. In every case, surgical adjuncts included surgical navigation based on new magnetic resonance imaging or computed tomography (CT) acquired the morning of surgery and the use of standard microneurosurgical techniques. The majority of cases were intra-axial tumours (i.e., gliomas and metastatic tumours). The details of the surgical

Table 1 Key steps of our protocol

1. Patient selection
Inclusion criteria for day surgery
<ul style="list-style-type: none"> • Supratentorial tumour • Caregiver availability overnight • Postoperative overnight stay close to hospital (home or hotel—within an hour drive from hospital) • Surgical duration < 4 hr to allow a minimum of 6 hr of postoperative observation
Exclusion criteria
<ul style="list-style-type: none"> • Neuropsychological unsuitability • Significant comorbidities (e.g., cardiovascular / respiratory insufficiencies) • Uncontrolled seizures • Poor neurological status • Patient's preference for inpatient stay
2. Patient preparation and education
<ul style="list-style-type: none"> • Preoperative assessment and preparation by both surgeon and anesthesiologist
3. Anesthesia
Awake craniotomy
<ul style="list-style-type: none"> • Adequate local anesthesia for pin sites and incision • Judicious and appropriate sedation and analgesia • Standard monitoring (minimal invasive) • No or minimal airway manipulation • Comfortable positioning and appropriate draping
General anesthesia
<ul style="list-style-type: none"> • Standard anesthesia management • Invasive monitoring and urinary catheter as indicated—not routine
4. Surgery
<ul style="list-style-type: none"> • Minimal, lesion targeted, image-guided flap—preferably through a linear skin incision • Avoid osmotic diuretics • Brain mapping in awake craniotomy-to localize eloquent brain function • Tumour resection • Fast closure (small flap, linear incision, no drainage)
5. Postanesthetic care unit observation (2 hr)
<ul style="list-style-type: none"> • Analgesia • Blood pressure control-target < 160/90
6. CT scan 4 hr postoperatively
7. Observation in the day surgery unit (at least 2 hr)
8. Discharge after neurosurgical evaluation with written instructions and caregiver (Appendix 2)

CT = computed tomography

procedure, including the incorporation of AC, have been extensively described elsewhere.^{15,17}

Anesthetic management

An intravenous catheter and all standard monitors (electrocardiogram, noninvasive blood pressure, and pulse oximetry) were applied to the patient following arrival in the operating room.¹⁸ Positioning of the patient was determined by the location of the lesion. General anesthesia was induced with intravenous propofol ($1\text{--}2\text{ mg}\cdot\text{kg}^{-1}$), lidocaine ($0.5\text{--}1\text{ mg}\cdot\text{kg}^{-1}$), fentanyl ($1\text{--}2\text{ }\mu\text{g}\cdot\text{kg}^{-1}$), and rocuronium

($0.6\text{ mg}\cdot\text{kg}^{-1}$) for tracheal intubation. Maintenance of anesthesia was accomplished with either sevoflurane or desflurane (titrated to an age-adjusted MAC of 0.8–1.1) and the infusion of remifentanyl ($0.01\text{--}0.1\text{ }\mu\text{g}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$). The patient's lungs were ventilated to an end-tidal CO_2 of 32–35 mmHg. The use of invasive arterial and central venous pressure monitoring and a urinary catheter was at the discretion of the anesthesiologist. The surgical incision site (excluding head frame pin sites) was also infiltrated with 0.25% bupivacaine (20–30 mL) with 1:200,000 epinephrine.

Patients undergoing an AC had the same monitors applied as for the GA group. Sedation was then started,

Figure Study flow chart. AC = awake craniotomy; GA = general anesthesia

which consisted of infusions of either intravenous dexmedetomidine or intravenous propofol-remifentanyl. Dexmedetomidine was administered as an initial loading dose ($1 \mu\text{g}\cdot\text{kg}^{-1}$ over ten minutes), followed by a maintenance infusion titrated to effect (doses ranging from $0.2\text{--}1 \mu\text{g}\cdot\text{kg}^{-1}\cdot\text{hr}^{-1}$). Continuous infusion rates of propofol and remifentanyl were $25\text{--}150 \mu\text{g}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ and $0.01\text{--}0.1 \mu\text{g}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$, respectively. During painful periods, such as the insertion of pins for the head frame and/or at any time when the patient required additional sedation or analgesia,

additional doses of intravenous fentanyl ($25\text{--}50 \mu\text{g}$), midazolam ($1\text{--}2 \text{ mg}$), and/or propofol ($10\text{--}20 \text{ mg}$) were administered. No airway (e.g., nasopharyngeal airway, other supraglottic device, or endotracheal tube) was inserted in any of the patients. The Sugita head frame was used for fixation of the patient's head to the operating table after the pin insertion sites were infiltrated with 2% lidocaine with 1:200,000 epinephrine and the scalp was infiltrated with 0.25% bupivacaine with 1:200,000 epinephrine in the form of a circular field block around the incision line.

The perioperative care of the patients (i.e., monitoring, analgesia, hemodynamic, and fluid management) was at the discretion of the attending anesthesiologist. Patients undergoing GA were awakened at the end of surgery and tracheal extubation ensued in the operating room.

Postoperative care and discharge

All patients were transferred to the postanesthesia care unit (PACU) directly from the operating room where they received standardized neurosurgical postoperative care for a minimum of two hours. Postoperative hypertension was treated with boluses of labetalol, esmolol, and/or hydralazine to maintain blood pressure < 160/90 mmHg. Once all PACU discharge criteria were met, the patients were then transferred to the day surgery unit (DSU) or to an inpatient ward. A postoperative monitored bed (i.e., high dependency unit) was considered only for patients with significant medical comorbidities or surgical complications. All patients who were scheduled for same-day discharge had a computed tomography (CT) scan of the brain approximately four hours postoperatively. If their postoperative course was uncomplicated and they met DSU discharge criteria, they were then discharged home with a family member about two hours after the CT scan. Our same-day discharge clinical care pathway and patient information leaflet are provided in Appendices 1 and 2.

Data collection

The sources used for data collection included the hospital's electronic patient records, the surgical and anesthesia records, as well as the surgical clinic notes. Two anesthesiologists reviewed the charts of all eligible patients and were involved in data collection. The following data were collected: patient demographics, medical and surgical comorbidities, anesthesia data (i.e., drugs, monitoring, fluid balance, intraoperative hemodynamic changes, complications, perioperative analgesic consumption), surgical data (i.e., tumour pathology, location, position, surgical complications), discharge characteristics (i.e., postoperative destination, hospital discharge time), and the rates and indications of hospital readmission.

Statistical analysis

The data were analyzed using Microsoft Excel (Microsoft Inc., Redmond, WA, USA). Normality of distributions was tested using the Shapiro-Wilk test. The parametric data are presented as mean (standard deviation [SD]) or median [interquartile range (IQR)] as indicated, with the categorical data presented as number (%).

The data were analyzed to determine the incidence of same-day discharge after supratentorial craniotomy for tumours. The perioperative factors were compared between patients

who had same-day discharge and those who were admitted after surgery as inpatients. Parametric data (e.g., age, mean duration of surgery, intraoperative opioid consumption) were analyzed with Student's *t* test, and the categorical data (e.g., demographics, patient comorbidities, perioperative care complications, and discharge characteristics) were analyzed with the Chi square test. All reported *P* values are two sided.

Results

During the study period, there were 514 patients who underwent craniotomy for supratentorial tumours, and 340 patients met the inclusion criteria (Figure). After excluding patients with missing charts ($n = 11$), 329 patients were included in the final analysis. The mean (SD) age and weight of the patients were 48 (12) yr and 76 (15) kg, respectively, with 164 males (49%). One hundred forty-six of the 329 patients (44%) were in the GA group, and the remaining 183 patients (56%) were in the AC group. Before the start of their procedure, three patients scheduled for AC were converted to GA due to anxiety, and their data were analyzed in the GA group. There were no intraoperative conversions to GA.

One hundred ninety-eight of the 329 (60%) patients (AC, $n = 157$; GA, $n = 41$) had been identified preoperatively as eligible candidates for same-day discharge. Of these 198 patients, 175 (88.4%) (AC, $n = 139$; GA, $n = 36$) were successfully discharged from the hospital on the same day as surgery. The reasons for the failure to discharge included new or worsening neurological deficits in nine (4.5%) patients, perioperative seizures in four (2.0%), severe headache with nausea and vomiting in four (2.0%), and other reasons in six (3.0%) patients (Figure).

Patient demographics, preoperative status, and tumour pathology are shown in Table 2. In general, patient demographics were similar between patients who had same-day discharge and those booked as inpatients, except for more patients with increased body mass index ($> 35 \text{ kg} \cdot \text{m}^{-2}$) and hypertension in the inpatient group and a higher incidence of patients presenting with seizures in the same-day discharge group. In patients who had same-day discharge, glioma and metastatic tumours were the most common pathology. In contrast, most patients with a meningioma were admitted to the hospital postoperatively. Perioperative anesthetic management is shown in Table 3.

Among the 175 patients who were discharged from the hospital, five (2.9%) patients (one GA, four AC) required readmission within the first 12 hr after discharge. The reasons for readmission included a seizure ($n = 1$), confusion ($n = 1$), development of hemiparesis ($n = 1$), headaches ($n = 1$), and bleeding from the wound ($n = 1$). No active treatment was required and all five patients were discharged home the following day (Table 4).

Table 2 Patient demographics and intraoperative characteristics

	Inpatient (<i>n</i> =154) (AC =44, GA =110)	Same-day discharge (<i>n</i> =175) (AC =139, GA=36)	<i>P</i> value
Age (yr)	47(13)	50(15)	0.18
Female	78(52%)	86(51%)	0.74
BMI >35 (kg·m ⁻²)	17(11%)	7(4%)	0.02
Weight (kg)	73(14.2)	75 (15.4)	0.22
Tumour pathology			
Glioma	55(36%)	72(41%)	0.17
Metastasis	24(16%)	49(28%)	0.001
Meningioma	40(26%)	20(11%)	0.001
Others	33(21%)	36(21%)	1.0
Duration of surgery (min)	143(31)	138(24)	0.1
Medical Comorbidities			
Sleep apnea	16(33%)	9(5%)	0.09
Coronary artery disease	10(6%)	7(4%)	0.33
Hypertension	46(30%)	34(19%)	0.03
Asthma	11(7%)	15(9%)	0.69
COPD	8(5%)	10(6%)	1.00
Diabetes	17(11%)	11(6%)	0.17
Non neurological malignancy	36(23%)	44(25%)	0.80
Seizures	54(35%)	82(47%)	0.03

All values are *n* (%) or mean (SD), where indicated; *n* = number; BMI = body mass index; COPD = chronic obstructive pulmonary disease; AC = awake craniotomy; GA = general anaesthesia

Table 3 Perioperative management

Perioperative management	Inpatient (<i>n</i> =154)	Same-day discharge (<i>n</i> =175)	<i>P</i> value
Monitoring			
Invasive arterial blood pressure	103(67%)	23(13%)	<0.001
Central venous pressure	6(3%)	0(0%)	0.01
Urinary catheter	89(58%)	11(6%)	<0.001
Intraoperative fentanyl use (µg)	177(89)	81(56)	<0.001
Osmotic therapy	1(1%)	15(10%)	<0.001
Total fluid administered (mL)	2,370 (430)	1,345 (665)	<0.001
Hypotension (>20% from baseline)	106(69%)	114(65%)	0.48
Use of vasopressors	85(55%)	39(22%)	<0.001
Use of anti-hypertensive medication	84(55%)	8(5%)	<0.001
Estimated blood loss >300 mL	54(35%)	6(3%)	<0.001
Use of colloid	16(10%)	1(1%)	<0.001
Blood transfusion	7(4%)	0(0%)	0.004
Postoperative opioid consumption (morphine equivalent) (mg)	23(16)	16(17)	<0.001
Antiemetic use in PACU	84(55%)	39(22%)	<0.001

All values are *n* (%) or mean (SD), where indicated; *n* = number; PACU = postanesthesia care unit

In total, 154 of the 329 (48%) patients were admitted as inpatients postoperatively. None of these patients required a postoperative ICU or monitored bed. Hospital discharge times for these patients are shown in the Figure. Overall,

86% (108/154) of patients were discharged from hospital within the first three postoperative days. The remainder were discharged within three weeks, except for three patients who developed postoperative complications

Table 4 Complications

	Age	Sex	Anesthesia	Details
Readmission after same-day discharge				
1	58	Female	Awake Craniotomy	Discharged at 1700 hr. Admitted overnight after one episode of focal seizure.
2	52	Male	Awake Craniotomy	Discharged at 1600 hr. Readmitted after 2000 hr with bleeding from the wound.
3	36	Female	Awake Craniotomy	Discharged in the evening. Patient woke up from sleep with confusion, came to emergency room at 0400 hr.
4	39	Male	General Anesthesia	Discharged in the evening, readmitted in the morning at 0900 hr with worsening aphasia.
5	55	Female	Awake Craniotomy	Discharged in the evening, readmitted at 2300 hr with worsening headache.
Postoperative hematoma				
1	58	Male	Awake Craniotomy	Postoperative (4 hr) CT finding—Asymptomatic, No surgical intervention. Discharged same day after 6 hr observation.
2	31	Male	Awake Craniotomy	Postoperative (4 hr) CT finding—Asymptomatic, No surgical intervention. Discharged same day after observation.
3	47	Female	General Anesthesia	Fluctuating level of consciousness 8 hr after surgery. CT scan—intracranial bleed. Reopening craniotomy. Poor outcome.
4	46	Male	General Anesthesia	Headache and altered level of consciousness in the immediate postoperative period. CT scan—extradural hematoma, Return to OR for evacuation. Good outcome.
5	47	Female	Awake Craniotomy	Decreased level of consciousness 12 hr postoperatively. CT scan—intracranial hematoma, Reopening craniotomy. Prolonged ICU stay.
6	56	Male	General Anesthesia	Intracranial bleed on postoperative day 3. Insertion of external ventricular drain. Poor outcome.

CT = computed tomography; ICU = intensive care unit; OR = operating room

(intracranial hematoma requiring evacuation) with prolonged ICU stay ($n = 1$) and death ($n = 2$).

In the GA group, 36 of 146 (25%) patients were discharged from hospital on the same day as surgery, with 110 (75%) being admitted as inpatients. In the AC group, 139 of 183 (76%) patients were discharged from hospital on the same day as surgery, with 44 (24%) being admitted as inpatients. Overall, the median [IQR] length of stay in the hospital was 3[3] days for craniotomy under GA and 1[1] day for AC.

Mean (SD) postoperative opioid consumption in the PACU (expressed as morphine equivalents) was significantly higher in the inpatient group than in the same-day discharge group [22.9 (16.4) mg vs 15.6 (16.5) mg, respectively; $P < 0.001$]. Similarly, more patients in the inpatient group received antiemetics in the PACU than patients in the same-day discharge group (84 vs 39, respectively; $P = < 0.001$).

Complications

Overall, preoperative neurological deficits were present in 58 of the 175 (33.1%) patients who had same-day discharge and in 69 of the 154 (44.8%) patients with inpatient craniotomy.

The incidence of new postoperative or worsening of preexisting neurological deficits was 24% (40/329), and this contributed to failure to discharge on the same day in nine patients. Six (1.8%) of the total 329 patients had a documented postoperative intracranial bleed (Table 4). None of these occurred after initial discharge from hospital.

Discussion

In this study, we assessed the feasibility of same-day discharge after craniotomy for supratentorial tumours in patients who had either GA or AC. Early discharge from hospital, including the same day, appeared to be feasible after both GA and AC, with 53% (175/329) of carefully selected patients being discharged on the same day and 86% (283/329) of patients being discharged within three days after surgery.

In general, neurosurgical patients are at a greater risk for adverse outcomes and diminished long-term functional status than the average surgical patients.¹⁹ A recent trend has been early discharge of patients from hospital after surgical procedures, transitioning towards a more outpatient-based surgical paradigm.^{20–22} Indeed, early hospital discharge for cancer patients expedites

chemotherapy and/or radiotherapy and also potentially improves patient outcomes by decreasing the time period between surgery and resumption of daily activities. This trend towards early discharge has been somewhat resisted by many in the field of intracranial tumour surgery. The most notable reason for this concern is safety, as there is a risk of significant neurological sequelae evolving outside of a monitored setting, with devastating consequences.²³⁻²⁶

The development of a postoperative hematoma is a well-known complication of any neurosurgical procedure, at times requiring a reopening of the craniotomy. Approximately 2% of patients undergoing an elective craniotomy will develop a postoperative hematoma requiring surgical evacuation.^{27,28} Nevertheless, Taylor *et al.* observed that 88% of patients who developed a postoperative hematoma following supratentorial craniotomy did so within six hours postoperatively.²⁸ In our study, six of the 329 (1.8%) patients developed an intracranial hematoma; three (0.9%) patients were diagnosed by changes in neurological status and required surgery within 12 hr, one patient required surgery on day 3, and two patients required no treatment. Nevertheless, no postoperative hematoma occurred after patients were initially discharged.

Other postoperative complications after intra-axial brain tumour surgery include the development of symptomatic edema, seizures, vasospasm, cerebrospinal fluid leaks, and wound infections. Postoperative edema peaks around the second and third day after surgery and occurs in up to 10% of patients.^{23,29} Neurosurgeons frequently observe patients clinically only through the swelling period, although the value of doing this is not clearly established.

In our centre, day surgery neurosurgical procedures have been performed for two decades. Previous reports have similarly shown the safety and efficiency of outpatient AC.^{9-12,30} Protocol success rates ranged from 89-98% in prospectively selected patients. The failure to discharge patients on the day of surgery or to readmit within 24 hr has largely been due to nausea/vomiting, worsening neurological status, intraoperative adverse events, and patient preference.¹² The rate of readmission of patients in our study (i.e., 2.8%) was comparable with those expected after a conventional prolonged hospital stay.¹¹ Initially, same-day discharge was considered mainly for the patients undergoing AC, and many of the patients needing GA stayed as inpatients. With more experience, however, we have now expanded our protocol to include patients undergoing GA.³⁰

The key surgical factors which are the basis for the success of our same-day discharge program include careful patient selection and a smaller craniotomy flap with linear scalp incision. In addition, shorter surgical duration (less than four hours) is important because a minimum of six hours of postoperative observation is required before the patient is discharged home. Similarly, our usual practice does not involve the use of invasive monitoring (e.g., arterial

and central venous pressure) and the use of urinary catheters; however, this is ultimately a decision made by the attending anesthesiologist for each patient. In our study, the use of both invasive monitoring and urinary catheters was higher in the inpatient group. This was probably due to the fact that the majority of the inpatients had GA, and anesthesiologists may prefer invasive monitoring in these patients as there may be greater hemodynamic variation and interventions.

Routine postoperative admission to an ICU for patients undergoing elective craniotomy is a long established practice, mostly for monitoring and treating serious postoperative complications that require urgent attention.^{5,6} Some recent studies have shown that routine admission to an ICU is not indicated after elective intracranial surgery.^{31,32} In a cohort of 3,000 neurosurgical patients transferred directly to an ICU postoperatively, Zimmerman *et al.* observed that 95.8% of the patients did not require any treatment during their stay in the ICU.³³ In our practice, we do not routinely admit patients to an ICU following tumour surgery and none of our patients in this study required admittance immediately after surgery.

The hospital discharge times in this study were similar to those in a previously reported study. In a retrospective analysis by Sughrue *et al.*, 213 of 313 (68%) patients undergoing elective intracranial keyhole surgery, performed with image guidance for tumours, cysts, and other masses, were discharged on postoperative day 1 or 2.³⁴ The authors concluded that consideration should be given to sending well-looking patients home to recover on postoperative day 1 or 2. Nevertheless, there were no same-day surgery procedures in their study.

We were interested in expanding our early discharge planning in neurosurgery to include patients undergoing GA as well as AC. We reasoned that the majority of patients who are otherwise well within the first four to six hours postoperatively generally remain well, are at low risk of developing complications, and thus could potentially be safely discharged home. The advantages of short hospital stays include the possible reduction of nosocomial infections, thromboembolism, and medical errors, along with the potential for significant cost savings. Qualitative studies on patients' perception of outpatient craniotomy have shown high patient satisfaction.³⁵ We did not assess this aspect in the present study. As long as patients are educated about warning signs requiring medical attention, most are pleased to attempt outpatient recovery; however, there are some exceptions. Some patients with brain tumours may experience a considerable amount of psychological distress at discharge. This issue must be taken into account and the threshold for readmission must be low.³⁶

This study has several limitations. First, this report is from a single institution and a single surgeon and thus might reflect the local practices relating to the experience of this one team. The surgical and anesthetic aspects of patient

management may not reflect those of other institutions. As well, our patient population may differ, as our patients may be more agreeable to accept the concept of earlier discharge from hospital. Thus, our results cannot necessarily be translated to other neurosurgical units. Second, this study was a retrospective review; hence, it suffers from all the limitations of a retrospective study, and it is possible that important clinical events may not have been adequately documented and thus not captured. Third, our study population size was relatively small (i.e., 329 patients), although it was comparable with other studies.^{34,37,38} The incidence of major neurologic complications after elective craniotomy is relatively low, thus we could not adequately outline risk factors for complications or readmission.

Conclusion

Early discharge from hospital, including the same day, is possible in carefully selected patients undergoing supratentorial tumour surgery (less than four-hour duration) after both GA and AC. The majority of patients who were well within the first four to six hours postoperatively remained well and were at low risk of developing complications.

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Editorial responsibility This submission was handled by Dr. Hilary P. Grocott, Editor-in-Chief, *Canadian Journal of Anesthesia*.

Appendix 1

Clinical care pathway for day surgery—brain tumours

Surgeon's clinic	Decision to Operate Discussion with patient for potential day surgery approach to care
Preadmission clinic	Seen by an Anesthesiologist • Clinical assessment to mitigate patient risk factors • Recommendations for suitability as day surgery patient

Appendix continued

Preoperative care unit (POCU)	<ul style="list-style-type: none"> • Patient arrives as the <i>first case</i> of the day • Transferred to medical imaging department for CT/MRI • POCU preparation of the patient • Patient reviewed by operating room team (surgeon, anesthesiologist, nursing) • Last minute questions answered
Operating room	<ul style="list-style-type: none"> • Patients undergoes surgical procedure (approximately 2–4 hr in length) • Awake craniotomy or general anesthesia • Invasive monitoring and urinary catheter as indicated—not routine • Neurosurgical team are responsible for booking the post-procedure CT
Postanesthetic care unit (PACU)	<ul style="list-style-type: none"> • Length of stay minimum 2 hr • Routine care of postoperative patient • Pain management protocol: fentanyl, morphine or hydromorphone, acetaminophen, or oxycodone as needed • Antiemetics as needed: dimenhydrinate, ondansetron, metoclopramide • Blood pressure control—Treat if systolic >160 mmHg with labetalol or hydralazine • Discontinue arterial line and urinary catheter prior to transfer to day surgery unit • Patient reviewed by anesthesia prior to transfer to the medical imaging department for CT • After CT scan patient transfer to day surgery unit
Day surgery unit	<ul style="list-style-type: none"> • Patients will be monitored for any potential complications, including neurological status, wound site bleeding. • A strict in / out fluid measurement • Pain management protocol: acetaminophen, oxycodone, codeine • Patients will be signed out by Neurosurgery—Staff/Fellow or Resident. • Patient receives prescription for pain acetaminophen with codeine, oxycodone. • Patient given follow-up clinic appointment 6 weeks post-surgery • Patient and caregiver receive day surgery discharge pamphlet with key patient information. • Patients receive a standard 24-hr follow-up phone call conducted by the day surgery nurses.

CT = computed tomography; MRI = magnetic resonance imaging

Appendix 2

Outpatient craniotomy—Discharge instructions for patients. Reproduced with permission from the University Health Network Patient and Family Education Program.

UHN

Outpatient Craniotomy

Discharge Instructions For Patients

Do not drive a car or drink alcohol for 24 hours

What you can eat and drink after your operation?

- You can progress as tolerated from fluids to solids to normal diet by tomorrow.
- If you feel nauseated (sick to your stomach) or you are vomiting you can get anti-nausea medication from your pharmacy without a prescription (Gravol). Take it as directed and continue with fluids until the nausea passes. Then gradually return to what you would usually eat.

How much activity is safe?

- Go home and rest today.
- You can begin with light activities 24 hours after your surgery. You can start by walking around your house. You may experience some lightheadedness or mild headache. This is normal and should gradually go away.
- Gradually increase your activities to normal.
- Your surgeon will tell you when you can go back to work and sports.

How to take care of your dressing (bandage) & wound

- Keep the dressing and incision clean and dry at all times.
- **Do not wet your head for 5 days.**

Reviewed by: Dr. M. Bernstein Neurosurgeon at TWH

Please visit the UHN Patient Education website for more health information: www.uhnpatienteducation.ca
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 Form: D-2898 (12/2012)

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 Toronto Western
 Princess Margaret
 Toronto Rehab

- Keep your head dressing on for 5 days, then **remove it and DO NOT put a dressing back on.**
- Do not be alarmed by the bruising, swelling or even a little wetness of the wound.
- Your family doctor should remove the staples in 10 to 14 days. The nurse should provide you with a staple remover before you leave the hospital, take it to your family doctor. Call your family doctor to make an appointment.
- If your surgeon has arranged Home Care, it will begin as planned by your Home Care Nurse.

When you can bathe or shower

- You may bathe or shower after 24 hours. But do not wet your head.
- Keep the incision clean and dry.
- You may wet your head after 5 days. Pat your head dry, gently.

How to cope with your pain

- It is normal to have some pain after this operation. The pain should get better with time.
- If you are given a prescription, take it to a pharmacy to get it filled and follow the directions for taking the medication.
- A mild headache is normal; you can take Tylenol Extra Strength 1 to 2 tablets every 4 to 6 hours if necessary.
- Some pain medications can make you constipated. To prevent constipation, drink lots of fluids (3 to 5 glasses of water every day - each glass should be about 8 oz.). Eat foods that are high in bulk (bran and fruit, for example). If you have not had a bowel movement for 72 hours, take 30ml of Milk of Magnesia. You can get this from your pharmacy without a prescription.

Other medications

- Continue with all the medications you were on before your surgery, i.e. Decadron, Dilantin, etc.
- If you have been given a prescription, take it to get filled at a pharmacy and take the medications as instructed by the pharmacist.

Problems to watch for

Call your surgeon or call (416) 340-3155 and ask to speak to the Neurosurgeon on call or go to Toronto Western Hospital Emergency Department (preferred) or the nearest hospital emergency department, if you have:

- **Ad decreased of level of consciousness**
- **Severe headache not helped by Tylenol**
- **Continuous vomiting**
- **Seizures**

Follow-up appointment

Call Dr. Bernstein's office at (416) 603-6499 to make an appointment 2-3 weeks after your surgery.

Doctor: Mark Bernstein (416) 603-6499

Location: _____

Date: _____

Time: _____

Special instructions for you:

For more information visit our web site at: www.uhn.ca

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