HHS Public Access

Author manuscript

Obes Surg. Author manuscript; available in PMC 2016 June 01.

Published in final edited form as:

Obes Surg. 2015 June ; 25(6): 1024–1030. doi:10.1007/s11695-014-1468-7.

Factors Associated with Prolonged Anesthesia Recovery Following Laparoscopic Bariatric Surgery: a Retrospective Analysis

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Abstract

Background—Phase I postanesthesia recovery is often prolonged after laparoscopic bariatric surgery. We hypothesized that postoperative respiratory depression is a major contributor to this delayed recovery.

Methods—Medical records of all patients who had a laparoscopic bariatric surgical operation from January 1, 2009, to December 31, 2012, were reviewed for clinical, anesthetic, and postanesthesia variables. Recoveries were defined as discharge from the recovery room in ≤90 min and in >90 min (*prolonged postanesthesia recovery*). We compared characteristics of patients without prolonged recovery to those with prolonged recovery.

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Conflict of Interest The authors declare that they have no conflict of interest.

Statement of Informed Consent This study was approved by the Mayo Clinic Institutional Review Board (IRB), Rochester, MN, and we included only patients who have provided authorization for research use of their medical records.

Statement of Human and Animal Rights Not applicable.

Results—Of 781 bariatric patients, 304 (38.9 %) had prolonged recovery. These patients had more respiratory depression (29 vs 6 patients), more postoperative nausea and vomiting (106 vs 92 patients), more treatments of hypertension in the recovery room (49 vs 33 patients), and more opioid treatment (median intravenous morphine equivalents [interquartile range], 10.0 [3.0–15.0] vs 5.0 [0.0–10.5]) (P<0.001 for all). On multivariable analysis, preoperative history of hypertension (P=0.03), fewer prophylactic antiemetics received (P= 0.02), and longer surgical duration (P=0.03) were associated with prolonged postanesthesia recovery.

Conclusions—Inadequate antiemetic prophylaxis and the treatment of postoperative hypertension were associated with prolonged postanesthesia recovery. Surprisingly, diagnosis of obstructive sleep apnea was not associated with prolonged recovery, which may be attributable to use of continuous positive airway pressure devices following emergence from anesthesia. Prolonged recovery in patients treated for hypertension may be related to institutional guidelines that require additional monitoring time after these medications are administered.

Keywords

Gastric bypass; Postanesthesia recovery; Respiratory depression

Introduction

Postoperative care is a complex system involving multiple clinical areas and health care providers. The postanesthesia care unit (PACU) is the lynchpin of this system and where patients undergo immediate phase I recovery from anesthesia before discharge to phase II recovery (in ambulatory settings, postoperative wards, and advanced monitoring wards). Effective movement of patients through the postoperative care system is critical to avoid patient flow bottlenecks and disruption of surgical practices [1]. Thus, identifying and mitigating potential delays in postanesthesia care are important. Our practice has set a goal time for phase I postanesthesia recovery of ≤90 min. In that context, we examined patient and procedural factors associated with prolonged PACU stay.

Among obese patients, obstructive sleep apnea (OSA) is a prevalent condition that predisposes to risk of postoperative respiratory complications [2]. In response to increasing rates of obesity in our surgical practice [3], our institution expanded the traditional measurement of respiratory depression from oxygen saturation (hypoxia) [4] to include apnea, hypopnea, and “pain-sedation mismatch” [5, 6]. Patients who had any of these respiratory depression events during postanesthesia recovery are now held longer in the PACU until respiratory depression resolves or, if it does not resolve, they are discharged to a higher level of care.

Because of the high prevalence of OSA among bar-iatric patients, we hypothesized that postoperative respiratory depression in these patients is a major component of delayed discharge from the recovery room. Our primary aim was to examine whether bariatric surgical patients with preoperatively diagnosed OSA have a higher rate of postoperative respiratory depression and therefore prolonged postanesthesia recovery. A secondary aim was to examine associations of other clinical and anesthetic variables with prolonged postanesthesia recovery.

Materials and Methods

This study was approved by the Mayo Clinic Institutional Review Board (IRB), Rochester, MN, and we included only patients who provided authorization for research use of their medical records.

Study Design

This study was a retrospective chart review of phase I postanesthesia recovery of patients who underwent laparoscopic bariatric surgery. We had established a goal time for discharge from phase I postanesthesia recovery of ≤90 min; therefore, *prolonged postanesthesia recovery* was defined as a time to discharge >90 min.

Patient Selection

Consideration for inclusion into this study was given to adult patients who underwent laparoscopic bariatric surgery and were transferred from the operating room to the PACU and provided research authorization for use of their medical records. Patients were excluded if they bypassed the PACU, had emergent surgery, or had revision surgery or had the same type of surgery but for reasons other than weight loss. However, patients with previous laparoscopic banding who underwent band removal and now were undergoing bariatric surgery were included.

Study Setting

The present study evaluated the practice of a major academic tertiary care facility with a high-volume bariatric surgical practice.

Preoperative Management

Patients enrolled in our bariatric surgical program have an initial thorough medical evaluation by an endocrinologist. The presence of obesity-related disorders, such as hypertension and diabetes mellitus, is routinely assessed and treated. Further, patients either undergo preoperative clinical assessment for OSA (overnight pulse oximetry or polysomnography) or are screened for OSA the day of surgery using Flemons criteria [7, 8]. Patients with a diagnosis of OSA are prescribed a continuous positive airway pressure (CPAP) device and are instructed to bring the device to the hospital.

Anesthetic Management

All operations are performed with general endotracheal anesthesia. Our practice model consists of an anesthesia team with a supervising anesthesiologist who manages up to four operating rooms, with in-room anesthesia care provided by an anesthesia resident, certified nurse anesthetist, or a student certified nurse anesthetist. Anesthetic management typically includes the use of desflurane for maintenance volatile because it is the least soluble agent and has faster anesthesia recovery than isoflurane [9]. In addition, because these patients have high risk of postoperative nausea and vomiting (PONV) (due to the typical characteristics of age <50 years, female sex, nonsmoker, laparoscopic procedure, and postoperative opioid analgesics) [10, 11], the use of triple antiemetic prophylaxis (i.e.,

droperidol [0.625 mg], dexamethasone [4 mg], and ondansetron [4 mg]) is encouraged [11, 12]. Vecuronium is the default neuromuscular blocking drug, and its administration is titrated with the aid of a peripheral nerve stimulator to the facial nerve in accordance with obtained train-of-four stimulation monitoring. Vecuronium is reversed at the conclusion of surgery with neostigmine that is coadministered with glycopyrrolate. Patients' tracheas are not extubated until they show clinical signs of full reversal (e.g., 5-s head lift, vigorous hand grip). However, details of care are left to the discretion of the supervising anesthesiologist. At the conclusion of surgery, the surgeons routinely infiltrate port sites with 0.25 % bupivacaine.

PACU Clinical Practice

The PACU is staffed by registered nurses trained in phase I recovery, as well as a first or second year anesthesia resident. The attending anesthesiologist is available when advanced expertise is required.

Discharge criteria for phase I recovery were based on criteria that assess five components:

- Motor activity (active motion, 2; weak motion, 1; no motion, 0)
- Respiration (coughs on command, 2; maintains airway without support, 1; required airway maintenance, 0)
- Blood pressure (systolic blood pressure ±20 mmHg of preanesthetic value, 2; systolic blood pressure ±20–50 mmHg of preanesthetic value, 1; systolic blood pressure ±50 mmHg or greater of preanesthetic value, 0)
- Consciousness (fully awake or easily aroused, 2; response to stimulus, 1; no response or absent protective reflexes, 0)
- Oxygen saturation, measured with pulse oximetry (saturations ≥93 % or preoperative value without supplemental oxygen, 2; saturations ≥93 % or preoperative value with supplemental oxygen, 1; saturations <93 % or preoperative value with supplemental oxygen, 0)

The patient's additive composite score needed to be 8 or greater and could not include a score of 0 in any of the five subcategories [4].

As an added layer of safety, continuous monitoring by PACU registered nurses evaluated four respiratory-specific events: hypoventilation (three episodes of <8 respirations/min); apnea (episode of apnea of ≥10 s); hypoxemia (three episodes of oxyhemoglobin desaturations measured with pulse oximetry [i.e., <90 % with or without nasal cannula]); and pain-sedation mismatch (defined as Richmond Agitation Sedation Score [13] of −3 to −5 and numeric pain score >5 [from a scale 0 to 10, with worst pain imaginable being 10]) [5, 6]. Any patient with a respiratory-specific event must have had a subsequent 60-min period free of further events to be transferred to a nonmonitored ward. Patients who had repeated events were discharged to an advanced-monitored setting or were continuously monitored for oxyhemoglobin desaturation with a pulse oximeter monitored through telemetry. For a patient with a CPAP or bi-level positive airway pressure (BiPAP) device,

the device was used on arrival to PACU until the patient was no longer sedated. Respiratory-specific events were recorded if they occurred while the patient was using CPAP or BiPAP.

In accordance with institution-specific protocols, patients who received intravenous hydralazine were monitored for reflex tachycardia for 120 min, and patients who received intravenous labetalol or metoprolol were monitored for symptomatic bradycardia for 30 or 60 min, respectively.

Data Abstraction

All data were abstracted from the electronic medical records and entered manually into the Web-based Research Electronic Data Capture system (version 3.6.7; Vanderbilt University) [14].

Presurgical variables were patient age, sex, body mass index, presence of OSA, hypertension (treated with medication), diabetes mellitus (treated with medication), coronary artery disease (i.e., previous myocardial infarction, percutaneous coronary intervention, coronary bypass surgery, stable angina, or stress test positive for myocardial ischemia), kidney function (as assessed by glomerular filtration rate calculated with the Modification of Diet in Renal Disease Study equation) [15], and regular use of the respiratory depressants benzodiazepines or opioid analgesics.

Anesthetic records were reviewed for surgical duration; agent used to maintain anesthesia; administration of midazolam, opioids, and antiemetics; and time required to meet phase I recovery criteria. Both the anesthetic and postanesthetic records were assessed for the occurrence of selected events, with use of the following criteria:

- Respiratory-specific events [5, 6]
- Administration of antihypertensive agents (β-adrenergic receptor antagonists or hydralazine)
- Administration of vasopressor medications
- Antiemetic prophylaxis, considered as triple therapy when administration of droperidol, dexamethasone, and ondansetron
- PONV, identified from documentation or use of rescue antiemetic medication

Intraoperative and postoperative opioid administration was converted to intravenous morphine equivalents through the use of published guidelines [16, 17].

Statistical Analysis

Data are presented as mean and standard deviation or median and interquartile range for continuous variables and as number and percentage of patients for categorical variables. The primary end point was a binary variable indicating phase I recovery time ≤90 vs >90 min. Preoperative clinical and intraoperative variables were included in multivariable logistic regression analysis to find associations with prolonged recovery. Additional exploratory post hoc analyses were performed. Two-sided tests were used, and *P* values ≤0.05 denoted

statistical significance. Statistical analyses were performed with JMP Pro 9.0.1 (SAS Institute Inc).

Results

In total, 781 patients underwent laparoscopic bariatric surgery and were enrolled in the study. Not included were two patients who did not give research consent, two patients whose procedures were aborted, and three patients who bypassed PACU. Prolonged recovery was identified in 304 patients (38.9 %). Of this cohort, 612 patients (78.4 %) underwent Roux-en-Y gastric bypass; 75 (9.6 %), sleeve gastrectomy; 71 (9.1 %), duodenal switch; and 23 (2.9 %), gastric banding surgery. Prolonged recovery rates did not vary by surgical type (P=0.25). All cases were primary surgery except the removal of gastric bands and conversion for Roux-en-Y gastric bypass in 14 cases and sleeve gastrectomy in 2 cases. Fifty six staff anesthesiologists supervised cases, but 615 cases (78.7 %) were supervised by eight staff anesthesiologists who supervised more than 20 cases. The rate of prolonged recovery did not differ by anesthesiologist (P=0.23). Table 1 presents patient and intraoperative factors of patients who recovered within 90 min vs those who did not. Of the 504 patients with OSA, 418 (82.9 %) used CPAP or BiPAP. Multivariable analysis found an association between history of hypertension and longer surgical duration with prolonged recovery. Use of triple antiemetics prophylactically was associated with increased likelihood to achieve recovery within 90 min.

Table 2 reports PACU events that could theoretically prolong phase I recovery. Post hoc analysis found that rates of respiratory-specific events did not differ among the patients who used CPAP or BiPAP vs those who did not (22 [5.3 %] vs 13 [3.6 %]; P=0.30). The rate of administration of antihypertensives in PACU was greater among patients with preexisting hypertension than those without it (66 [14.3 %] vs 16 [5.0 %]; P<0.001). Among the subset of hypertensive patients, the median [interquartile range] number of preoperative antihypertensive medications was less in patients with prolonged recovery than those who met goal discharge time (2 [1–2] vs 2 [1–3]; P=0.02) and did not vary among patients treated or not treated with antihypertensives in the PACU (1 [1–2] vs 2 [1–3]; P=0.18).

The median length of hospital stay was longer for patients who had prolonged recovery (3 [2–3] vs 2 [2–3] days; P<0.001), but the rates of admission to advanced monitored units (e.g., intensive care units) (32 [10.5 %] vs 31 [6.5 %]; P=0.06) and readmission to the hospital after discharge (27 [5.7 %] vs 19 [6.3 %]; P=0.76) did not differ. No in-hospital death occurred, although one patient died at home of unknown causes within 30 days postoperatively.

Discussion

The PACUs use considerable health care resources, with personnel costs being the primary expense [18, 19]. Reduction of postanesthesia recovery times could translate into both more efficient PACU practice and health care savings. Our main finding was that among laparoscopic bariatric surgical patients, a history of OSA was not associated with an increased rate of respiratory-specific events or with prolonged postanesthesia recovery. The

most common event associated with prolonged recovery was PONV, and use of prophylactic triple antiemetics increased the likelihood of faster discharge. History of hypertension and the need for postoperative antihypertensive treatment were associated with prolonged recovery time.

The high prevalence of OSA among bariatric surgical patients has been well established [20]. A serious postoperative complication in patients with OSA is hypercapnic respiratory failure [2]. Widely used phase I postanesthesia recovery discharge criteria do not specifically assess for hypoventilation or apnea [4]. Our institution has expanded this respiratory parameter to include hypoventilation, apnea, hypoxemia, and pain-sedation mismatch [5, 6]. Gali et al. [6] previously reported that surgical patients with a screening test positive for OSA had increased rate of respiratory-specific events. Thus, we hypothesized that bariatric surgical patients with OSA would have higher rates of events and these would be major contributors to postanesthesia recovery delays. However, we did not find this association, which suggests that our practice of applying the patient's CPAP or BiPAP after emergence from anesthesia may be sufficient to mitigate postoperative hypoventilation.

This conclusion is supported by our post hoc analysis, which did not find a greater rate of postoperative respiratory depression in patients prescribed CPAP or BiPAP (and therefore presumably the more serious cases of OSA) than other patients. Lack of association between OSA and immediate postoperative respiratory events is in agreement with a previous study where we found that when appropriately treated (CPAP application), bariatric surgical patients with OSA (regardless of severity) did not have greater rates of postoperative respiratory complications than patients without OSA [20].

In our bariatric patients, PONV was the most common cause for prolonged postanesthesia recovery. These results are hardly surprising when considering our practice and the published guidelines on prevention and treatment of this complication [11]. Patients having bariatric surgery have several known risk factors for PONV, including laparoscopy, need for perioperative use of opioids, use of volatile anesthetics, and the fact that the majority of patients receiving this procedure are younger women who are nonsmokers [11].

An estimated 40 % of female surgical patients who receive postoperative opioid analgesics have PONV [10]. Multimodal antiemetic prophylaxis with droperidol, dexamethasone, and ondansetron has been recommended for patients such as ours who have multiple risk factors [12, 21]. Unfortunately, provider compliance with recommended antiemetic prophylaxis protocols is low historically [12]. Despite a strong emphasis in our practice for triple antiemetic prophylaxis, only 42.3 % of our patients received triple antiemetic therapy. Given these results, it would be logical to attempt to further lower the PONV rates through more aggressive use of antiemetics. However, whether such an approach would reduce postanesthesia recovery times in this patient population has not been studied.

We found that both a history of hypertension and postoperative antihypertensive medications were associated with prolonged recovery. Further, post hoc analysis showed that patients with hypertension were more likely to be treated with intravenous antihypertensive agents during recovery. These associations are likely related to institution-

specific protocol that requires additional monitoring (i.e., time spent in PACU) after administration of hydralazine (120 min), labetalol (30 min), and metoprolol (60 min). This speculation is supported by an observation that intraoperative antihypertensive medications were not associated with prolonged recovery because intraoperative antihypertensive medications are not subject to these monitoring guidelines. These guidelines are institution-specific and do not reflect national guidelines. This outcome highlights the importance of considering practices that are idiosyncratic to an institution when performing analyses of practice metrics. This retrospective study was not able to quantify the severity of hypertension, and post hoc analyses did not find an association with the number of prescribed preoperative antihypertensive medications and prolonged recovery.

Another limitation, this study represents the practice of a major academic institution with involvement of surgical and anesthesia trainees in every case. Trainee involvement could influence surgical duration, which was associated with prolonged postanesthesia recovery. This characteristic could represent a source of bias and limit the generalizability to other practices. Further, numerous staff anesthesiologists supervised these cases; however, most cases were covered by eight anesthesiologists.

Conclusion

Despite the high OSA rate among laparoscopic bariatric surgical patients, the rates of postoperative respiratory depression during phase I recovery were low in appropriately treated patients and were not associated with prolonged stay in the recovery room. The most common cause of delayed postanesthesia recovery was PONV, which suggests more aggressive antiemetic prophylaxis might reduce postanesthesia recovery time. Observations that preoperative hypertension and use of postoperative antihypertensives increase postanesthesia recovery time may reflect institution-specific protocols that mandate additional monitoring after use of these medications. Providing that this finding of increased risk of delayed discharge is true, it may not be observed in other practices.

Acknowledgments

This project was supported by the Department of Anesthesiology, College of Medicine, Mayo Clinic, Rochester, MN, and the National Institutes of Health/National Center for Research Resources Clinical and Translational Science Award grant numbers UL1 RR024150 and KL2 RR024151.

Abbreviations

BiPAP	Bi-level positive airway pressure
CPAP	Continuous positive airway pressure
OSA	Obstructive sleep apnea
PACU	Postanesthesia care unit
PONV	Postoperative nausea and vomiting

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Table 1

Association between demographic characteristics, comorbidities, perioperative factors, and postanesthesia recovery

Characteristics	Prolonged recovery[a]		*P* value	Odds ratio (95 % CI)	*P* value[b]
	No (*n*=477)[c]	Yes (*n*=304)[d]			
Age, mean (SD), years	47.82 (12.10)	48.93 (11.95)	0.21	1.00 (0.98–1.02)	0.86
Male sex	102 (21.4)	71 (23.4)	0.52	1.20 (0.82–1.76)	0.35
Comorbidities and preoperative medications					
Body mass index, mean (SD), kg/m^2	44.52 (8.00)	46.02 (8.52)	0.01	1.01 (0.99–1.03)	0.23
Diabetes mellitus	157 (32.9)	131 (43.1)	0.005	1.23 (0.88–1.72)	0.23
Hypertension[e]	260 (54.5)	203 (66.8)	<0.001	1.49 (1.03–2.15)	0.03
Cardiac disease	29 (6.1)	25 (8.2)	0.25	1.15 (0.63–2.07)	0.65
Obstructive sleep apnea[f]	297 (62.3)	207 (68.1)	0.11	1.07 (0.76–1.51)	0.71
Glomerular filtration rate, mean (SD), mL/min/17.3 m^2	83.66 (22.9)	83.47 (26.95)	0.92	1.00 (0.99–1.01)	0.56
Regular benzodiazepine and/or opioid treatment	69 (14.5)	52 (17.1)	0.32	1.05 (0.69–1.57)	0.83
Intraoperative factors					
Surgical duration, mean (SD), min	215 (55)	226 (54)	0.006	1.00 (1.00–1.01)	0.03
Desflurane volatile[g]	403 (84.5)	255 (83.9)	0.84	1.09 (0.72–1.66)	0.70
Midazolam	233 (48.9)	158 (52.0)	0.39	0.93 (0.67–1.28)	0.64
Triple antiemetic prophylaxis[h]	221 (46.3)	109 (35.9)	0.005	0.68 (0.49–0.94)	0.02
Intravenous morphine equivalents, median (interquartile range), mg	35.0 (28.0–41.5)	35.5 (29.0–44.7)	0.41	1.00 (0.99–1.01)	0.61
Antihypertensive medication[i]	100 (21.0)	80 (26.3)	0.10	1.16 (0.80–1.66)	0.43
Vasopressor medication[j]	332 (69.6)	201 (66.1)	0.34	0.80 (0.57–1.12)	0.19

[a] Values are presented as number and percentage of patients unless specified otherwise

[b] From logistic regression analysis and were summarized with odds ratios and corresponding 95 % confidence intervals

[c] Phase I postanesthesia recovery within 90 min of arrival

[d] Phase I postanesthesia recovery at >90 min of arrival

[e] The median [interquartile range] number of antihypertensive medications for hypertensive patients was 2 [1–2]

[f] Obstructive sleep apnea was diagnosed through polysomnography in 479 cases, and 25 additional patients were deemed at high risk through preoperative screen on the day of surgery

[g] The other patients received isoflurane, sevoflurane, several volatile agents throughout the surgery, or a mixed technique of propofol infusion with a volatile agent

[h] Consisted of droperidol (0.625 mg), dexamethasone (4 mg), and ondansetron (4 mg)

[i] Seven patients in *each* study group received hydralazine (all patients in each group also received β-adrenergic blocking medications)

[j] Given as bolus doses of either phenylephrine or ephedrine

Table 2

Postanesthesia care unit events that could delay recovery from anesthesia

Events of treatments	Prolonged recovery[a]		*P* value
	No (*n*=477)[b]	Yes (*n*=304)[c]	
Respiratory-specific events	6 (1.3)	29 (9.5)	<0.001
Postoperative nausea and vomiting	92 (19.3)	106 (34.9)	<0.001
Intravenous morphine equivalents, median (interquartile), mg	5.0 (0.0–10.5)	10.0 (3.0–15.0)	<0.001
Antihypertensive medication administration[d]	33 (6.9)	49 (16.1)	<0.001
Vasopressor medication administration[e]	0	2 (0.7)	0.15

[a] Values are presented as number and percentage of patients unless specified otherwise

[b] Phase I postanesthesia recovery ≤90 min

[c] Phase I postanesthesia recovery >90 min

[d] Hydralazine was administered to 3 patients discharged in ≤90 min and to 13 patients discharged in >90 min. Labetalol was administered to 43 vs 29 patients and metoprolol to 2 vs 2 patients in the groups discharged in ≤90 vs >90 min, respectively

[e] Phenylephrine boluses were administered to 2 patients