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Original Article

Perioperative complications and Intensive Care Unit utilization in super-superobese patients undergoing laparoscopic bariatric surgery

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Abstract

Objective: Anesthetic management for super-superobese (SSO) patients (body mass index [BMI] ≥60 kg/m^2) presents a challenge for anesthesiologists. This study aimed at characterizing the early complications and Intensive Care Unit (ICU) utilization in SSO patients receiving laparoscopic bariatric surgery. **Materials and Methods:** Totally, 25 SSO patients receiving laparoscopic bariatric surgery between June 2006 and December 2011 were reviewed. The data collected included patient demographics, preoperative comorbidities, anesthetic techniques, airway management, perioperative adverse events, ICU utilization, and early complications occurring within 30 days of index surgery. Early complications were defined as the adverse events that led to permanent detrimental effects or required significant additional intervention. **Results:** A retrospective analysis was performed on data from 25 consecutive SSO patients (age: 31.2 ± 11.1 years; BMI: 64.9 ± 4.7 kg/m^2). Tracheal intubation was attempted successfully in all patients but was difficult in two cases when using laryngoscopy. Bronchospasm was observed in five cases (20%) after tracheal intubation. Postoperative ICU utilization was required in five cases (20%). Early complications occurred in two cases during their stay in postanesthesia care unit (including one case of respiratory failure and one case of hyperkalemia) and in two cases during their stay in ICU (both with respiratory failure). The incidence of early complications was 16%. All patients were discharged from the hospital without sequelae. **Conclusions:** It is imperative to anticipate the potential for developing perioperative adverse events and postoperative complications in SSO patients after bariatric surgery. Appropriate utilization of ICU resources may enhance patient safety.

Keywords: *Anesthesia, Early complications, Intensive Care Unit utilization, Super-superbase*

Introduction

Bariatric surgery has become an increasingly utilized therapeutic option for patients with morbid (body mass index [BMI] >40 kg/m^2) or complicated (BMI of 35–40 kg/m^2 with comorbidities) obesity to obtain sustainable weight loss [1]. However, morbidly obese (MO) patients often have a high prevalence of cardiopulmonary diseases and multiple comorbidities, which often predispose these patients to an increased risk of postoperative morbidity and mortality. In addition, because of anatomic and physiologic changes in obese patients [2], a high BMI was reported to positively correlate with the risks of intraoperative atelectasis [3], difficult mask ventilation [4], difficult airway management [5], and reduced cardiorespiratory fitness [6]. A previous study demonstrated no differences in outcome between MO patients (BMI 40–49.9 kg/m^2) and superobese (SO) patients (BMI ≥50 kg/m^2), including super-SO (SSO) (BMI ≥60 kg/m^2), undergoing bariatric operations under similar anesthetic management [7]. However, because of small number of SSO patients (i.e., n = 5) in that study [7], the present investigation was designed to further address the bariatric surgery-associated perioperative complications in this particular patient population. Here, we report the anesthetic management of the initial 25 SSO patients undergoing laparoscopic bariatric surgery in a tertiary referral center. We summarized the perioperative adverse events and early perioperative complications encountered in SSO patients. The incidence, indications, and outcomes of patients requiring Intensive Care Unit (ICU)

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utilization after laparoscopic bariatric surgery were also analyzed.

Materials and methods

After approval from the institutional review board of E-Da Hospital (EMRP-107-008), we retrospectively reviewed the data of 25 SSO patients between June 2006 and December 2011 from the anesthesia database of our institution. The study population comprised SSO patients who underwent bariatric surgeries and received tracheal intubation under general anesthesia. Patients were excluded if they had a history of abdominal surgery before the index surgery or the surgery was not performed electively. The study was conducted in accordance with the Declaration of Helsinki and was approved by the local ethics committee of the institute. Informed written consent was waived because the study was a retrospective data analysis.

Preoperative evaluation

All patients were evaluated for potential difficulty in airway management before surgery (between 2 and 4 weeks) in an anesthetic assessment clinic. Data including laboratory tests as well as results of electrocardiography (ECG), chest radiography, pulmonary spirometry, abdominal echography, and gastroscopy were also reviewed. Pulmonary function tests were selectively performed on patients with a notable history and/or findings on preoperative physical examination, including those with pulmonary disease, dyspnea on exertion, or limited functional capacity. Pulmonary function test abnormalities were classified as minor, moderate, or severe. In our hospital, since polysomnography is not routinely performed before bariatric surgery, the diagnosis of obstructive sleep apnea was made based on the patients' medical histories.

Anesthesia and airway management

Routine monitoring included ECG, noninvasive blood pressure, pulse oximetry, end-tidal CO_2 ($EtCO_2$), and body temperature measurements. Invasive arterial blood pressure and central venous pressure were monitored in patients with severe cardiovascular comorbidities. All patients were preoxygenated in a 30° reverse Trendelenburg position. After anesthetic induction with propofol or thiopental sodium, nondepolarizing muscle relaxant (rocuronium or cisatracurium) was used to facilitate tracheal intubation with a Macintosh laryngoscope and Flexislip stylet (Willy Rüsch AG, Kernen, Germany) which is a common practice at our institution for airway establishment. For SSO patients, a fiberoptic bronchoscope, McCoy laryngoscope (Truphatek International Ltd., Netanya, Israel), Trachway® intubating stylet (Biotronic Instrument Enterprise Ltd., Taichung, Taiwan), and other airway instruments (e.g., an intubating laryngeal mask airway) were available in the operating room for airway rescue. After tracheal intubation, inhalation agents were used to maintain the anesthetic depth. A calibrating orogastric tube (36 F gauge; Obtech Medical Sàrl, Le Locle, Switzerland) was inserted through the esophagus into the stomach for gastric decompression and pouch formation. The calf-length pneumatic compression device was used for venous thromboembolism (VTE) prophylaxis.

Volume-controlled or pressure-controlled mechanical ventilation was initially set at a respiratory rate of 12 breaths/min and a tidal volume of 12–15 mL/kg based on ideal body weight. Afterward, mechanical ventilation was modified to maintain an $EtCO_2$ of 35–40 mmHg and peak airway pressure of <35 cmH_2O. During laparoscopic bariatric surgeries, intra-abdominal insufflation pressure was constantly maintained at between 12 and 15 cmH_2O. At the end of surgery, neuromuscular blockade was reversed with reverse agents. Before tracheal extubation, the patient must be able to squeeze his/her hand and lift head off the bed and hold it up for 5 s. Tracheal extubation was performed on fully awake patients in 30° reverse Trendelenburg position.

Postoperative care

After tracheal extubation was completed in the operating room or in the postanesthesia care unit (PACU), oxygen supplement via face mask was provided to maintain oxygen saturation >95% and bolus dose of morphine (5–10 mg) was given if required in the PACU. Bedside monitoring of the patient's respiratory status was performed intensively. Coughing and deep breathing were encouraged while in the PACU. After discharge to the ward, SSO patients were encouraged to ambulate early and bolus dose of nalbuphine was used as the analgesics for postoperative pain.

Data collection and analysis

The anesthetic records, operative notes, admission records, and discharge summaries of these patients were reviewed, and the following data were collected retrospectively: patient characteristics, preexisting comorbidities, preoperative examinations and laboratory data, surgical procedure, anesthetic techniques, characteristics of recovery, and length of hospital stay as well as the incidences of difficult tracheal intubation (attempt of tracheal intubation >2), intraoperative adverse events, early complications, and ICU utilization. Adverse events were defined as transient detrimental effects or needs for further intervention. Early complications (those occurring within 30 days of index surgery) were defined as the adverse events that led to permanent detrimental effects or required significant additional intervention. The data were summarized using descriptive statistics and presented as the mean (standard deviation) or number (proportion) as applicable. Paired *t*-tests were used to analyze the significance of differences in hemodynamic data at each time point. Data were analyzed using SPSS version 13 for Windows (SPSS Inc., Chicago, IL, USA). A $P < 0.05$ was considered statistically significant.

Results

The data from 25 consecutive SSO patients (age: 31.2 ± 11.1 years; BMI: 64.9 ± 4.7 kg/m^2) undergoing laparoscopic bariatric surgery were retrospectively reviewed. All the surgical procedures were performed by a single surgeon. The demographic data, number of comorbidities per patient, type of operation, comorbidities, and abnormal laboratory examination are shown in Tables 1-3, respectively. The laparoscopic Roux-en-Y gastric bypass (LRYGB) was performed in 96% of patients (n = 24), and this surgical technique has been described in details previously [8]. Due to technical difficulty,

Table 1: Demographic and clinical data of super-superobese patients and type of operation (*n*=25)

Patient characteristics	Mean±SD or *n* (%)
Age (years)	31.2±11.1
Gender (males; females)	11; 14
Weight (kg)	175.4±25.7
Height (cm)	163.9±9.3
BMI (kg/m²)	64.9±4.7
ASA II/III	6; 19
Type of surgery	
Gastric bypass	24 (96)
Gastric banding	1 (4)

ASA: American Society of Anesthesiologists, SD: Standard deviation, BMI: Body mass index

Table 2: Preoperative comorbidities in super-superobese patients (*n*=25)

Parameters	Number of patients (%)
Hypertension	12 (48)
Coronary artery disease	1 (4)
Diabetes mellitus	9 (36)
Hyperlipidemia	6 (24)
Hepatitis	3 (12)
Fatty liver*	22 (88)
Gastroesophageal reflux	9 (36)
Gastritis	18 (72)
Sleep apnea syndrome**	5 (20)
Asthma	2 (8)

*Severity of fatty liver: Mild, *n*=4; moderate, *n*=5; severe, *n*=13, **Diagnosis made based on previous history. No patient requiring CPAP treatment preoperatively. CPAP: Continuous positive airway pressure

the LRYGB procedure was converted to a mini-gastric bypass for one patient with a BMI of 71.6 kg/m². All of the procedures were performed laparoscopically with no conversions to laparotomy.

Tracheal intubation was attempted successfully in 92% of patients (*n* = 23) using a short handle laryngoscope or a McCoy laryngoscope, and difficult tracheal intubation with laryngoscopy was documented in two patients. Awake fiberoptic endotracheal intubation was performed successfully in 8% of the patients (*n* = 2). Difficult mask ventilation or difficult tracheal intubation was not observed in patients with a history of obstructive sleep apnea (*n* = 5). Respiratory and hemodynamic adverse events are shown in Table 4. After tracheal intubation, occurrence of bronchospasm was documented in five patients (20%) and one patient developed transient hypoxemia (SaO_2 = 91%) intraoperatively. Despite intervention with bronchodilator, the patient suffered from a high peak airway pressure (ranged from 33 to 40 cmH_2O) and hypercapnia ($EtCO_2$ ranged from 61 to 75 mmHg) intraoperatively. The patient, who was sent to ICU for observation postoperatively, later received tracheal reintubation because of respiratory failure. The hemodynamic change after anesthetic induction and CO_2 pneumoperitoneum is shown in Figure 1. Compared with the baseline mean blood pressure (MBP), there was a significant decrease in MBP after anesthetic induction ($P < 0.001$) and CO_2 insufflation ($P < 0.001$). Compared

Table 3: Incidence of abnormal laboratory tests or examinations in super-superobese patients (*n*=25)

Parameters	Number of patients (%)
Abnormal liver function*	14 (56)
Abnormal renal function	1 (4)
Abnormal electrocardiographic findings	4 (16)
Abnormal chest radiographic findings	7 (28)
Abnormal pulmonary function test**	10 (47.6)

*Abnormal plasma levels of AST (defined as values >40 units per liter) or ALT (defined as values >56 units per liter), **Pulmonary function test was performed in 21 patients. AST: Aspartate transaminase, ALT: Alanine transaminase

Table 4: Intraoperative respiratory and hemodynamic adverse events

Parameters	Number of patients (%)
Respiratory adverse events	
Hypercapnia ($EtCO_2$ >45 mmHg) after CO_2 pneumoperitoneum	8 (32)
High peak airway pressure (>35 cmH_2O)	8 (32)
Episode of desaturation (arterial oxygen saturation <92%)	1 (4)
Bronchospasm	5 (20)
Hemodynamic adverse events	
Hypertension episodes (SBP >140 mmHg)	8 (32)
Hypotension episodes (SBP <90 mmHg)	10 (40)
Tachycardia (heart rate >100 beats/minute)	12 (48)
Bradycardia (heart rate <60 beats/minute)	4 (16)

$EtCO_2$: End-tidal CO_2, SBP: Systolic blood pressure

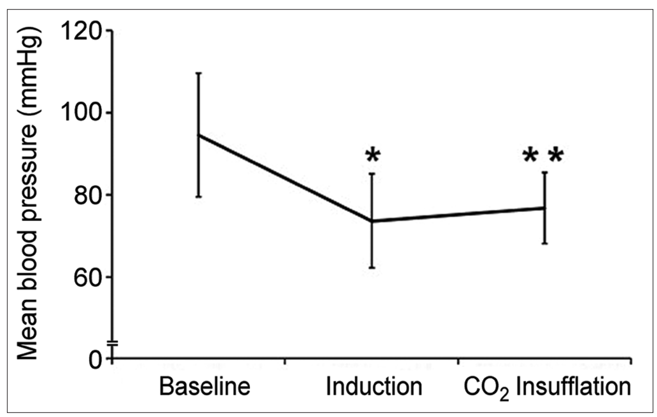

Figure 1: Changes in MBP before anesthesia (i.e. baseline), immediately after anesthetic induction, and after creation of CO_2 pneumoperitoneum. *$P < 0.001$ compared to baseline; **$P < 0.001$ compared to baseline; no significant difference between MBP immediately after induction and that after CO_2 insufflation ($P = 0.252$). CO_2: Carbon dioxide, MBP: Mean blood pressure

with the MBP after anesthetic induction, the use of CO_2 insufflation did not have a significant impact on MBP ($P = 0.252$).

The recovery characteristics of these patients are shown in Table 5. Unplanned ICU admission was required in five patients (20%). The indications for ICU utilization and subsequent complications are shown in Table 5. The decision for ICU utilization was made in three patients during surgery and in two patients during their stay in PACU. Unexpected tracheal reintubation was performed in one patient because

Table 5: Anesthetic time, recovery characteristics, and complications in super-superobese patients with or without Intensive Care Unit utilization

Non-ICU utilization (*n*=20)	**Mean±SD (range) or *n* (%)**
Total anesthetic time (min)	250±56 (170-370)
PACU adverse events	
Wound pain	15 (75)
Hypothermia*	5 (25)
Nausea/vomiting	6 (30)
Bronchospasm	1 (5)
PACU aldrete score at discharge	9.5±0.6 (8-10)
Oxygen supplement in the ward	10 (50)
Length of PACU stay (min)	86.5±31.7 (40-150)
Length of hospital stay (days)	3.5±1.7 (2-7)
ICU utilization (*n*=5)	**Mean±SD (range) or *n* (%)**
Total anesthetic time (min)	294±92.8 (205-430)
Reasons for unplanned ICU admission	
Prolonged surgical time**	1 (20)
Perioperative desaturation	1 (20)
New onset of STT change	1 (20)
Respiratory failure in PACU	1 (20)
Acute conscious change***	1 (20)
Early complications	
Pulmonary atelectasis	2 (40)
Respiratory failure and anastomotic leak	1 (20)
Metabolic acidosis and hyperkalemia	1 (20)
Length of ICU stay (h)	33.8±20.6 (15.5-63)
Length of hospital stay (days)	8.8±9.8 (3-26)

*Hypothermia: nasopharyngeal temperature <35.5°C, **Prolonged surgical time due to technical difficultly, ***Coma scale change from E4VEM6 to E1VEM1. PACU: Postanesthesia care unit, ICU: Intensive Care Unit, SD: Standard deviation, STT: ST-T wave

of acute respiratory failure and acute conscious change in the PACU (coma scale: E4VEM6–E1VEM1). Arterial blood gas analysis in this unconscious patient revealed pH, PaO_2, $PaCO_2$, potassium, HCO_3, and base excesses of 7.19 mmHg, 96.8 mmHg, 46.2 mmHg, 7.02 mEq/L, 17.2 mEq/L, and −10.9 mEq/L, respectively. In these five patients, preoperative pulmonary function tests demonstrated only mild impairment in three patients, and this examination was not performed in the other two. All SSO patients (*n* = 25) were discharged from the hospital without sequelae or 30-day readmission.

Discussion

This study represents the first investigation focusing on anesthesia-related adverse events, complications, and the need for ICU utilization in SSO patients. The findings of our study bear several striking clinical implications. First, tracheal intubation, either with laryngoscope or fiberscope, can be first attempted with backups of airway rescue devices as reflected in the 100% success rate of tracheal intubation in our SSO patients. Second, our results showed that respiratory adverse events such as bronchospasm, gaseous and airway pressure anomalies, as well as hemodynamic adverse events are not uncommon in SSO patients. Third, the high incidences of ICU utilization and early complications (i.e., 25% and 16%, respectively) and the most frequent early complication of respiratory failure in our SSO patients highlight the necessity of intensive postoperative monitoring and management for this patient population.

Difficult tracheal intubation and difficult mask ventilation are common among obese patients [2,4,5]. Precautions at our institute during induction in general anesthesia for SSO patients included preoxygenation in a 30° reverse Trendelenburg position and preparation of rescue airway devices required for securing the airway. In spite of the two cases of failed intubations in our series, the airway was established successfully in all patients. Although there is insufficient evidence to support increased BMI alone as an independent predictor of difficult laryngoscopy or difficult intubation [9,10], obese patients are prone to suffer from desaturation during induction of anesthesia [11] and obesity is a predisposing risk factor for difficult mask ventilation [4]. Therefore, careful selection of the suitable method, equipment, and rescue devices required for securing the airway of SSO patients is mandatory.

Because of obesity-associated physiologic changes and comorbidities, respiratory adverse events are not uncommon in SSO patients [2]. Pneumoperitoneum during laparoscopic bariatric surgery also worsens respiratory mechanics and predisposes SSO patients to perioperative atelectasis [12]. We found that the occurrence of bronchospasm may have a significant impact on subsequent early respiratory complications. One of our patients, who developed intraoperative bronchospasm after tracheal intubation, suffered from intraoperative desaturation and postoperative respiratory failure. The high prevalence of bronchospasm (20%, *n* = 5) after tracheal intubation in our series is consistent with the previous finding that increasing obesity is associated with a significant increase in airway responsiveness [13,14] and that bronchospasm is more common in obese than lean children undergoing general anesthesia [15]. Additional strategies should be developed to mitigate this pulmonary adverse event in SSO patients during airway management.

The incidence of pulmonary complications after bariatric surgery has been reported to range from 4% to 7% [16]. A greater BMI is found to correlate with a high incidence of pulmonary embolism and respiratory failure after bariatric surgery [17,18]. In our series, postoperative respiratory failure occurred in three male patients (12%) with concurrent mild obstructive lung disease, for whom prolonged surgical time, intraoperative pulmonary adverse events, and concurrent surgical complications may be potential contributors. On the other hand, VTE, which includes pulmonary embolism and deep vein thrombosis, is one of the potentially life-threatening complications that may occur within 6 months following bariatric surgery [19]. In our series, the absence of this complication may be attributed to the use of calf-length pneumatic compression devices before anesthesia induction and mandatory ambulation beginning on the day of operation, which are routine practice at our institute.

In our series, hyperkalemia (i.e., plasma potassium >5.3 mEq/L) occurred postoperatively in a diabetic patient with uneventful anesthesia. This patient presented with an altered mental status during his/her PACU stay without further complications after medical intervention. Postoperative rhabdomyolysis, which is a possible cause of hyperkalemia, has been reported in postoperative obese patients [20]. The reported incidence of rhabdomyolysis in obese patients following laparoscopic bariatric surgery varies widely, ranging from 1.4% to 22.7% [21,22]. There is an increased risk of postoperative rhabdomyolysis for patients with massive obesity (BMI >60 kg/m^2) and for those undergoing long operations (>4 h) [22]. The presence of diabetes is also identified as a factor associated with an increased risk of rhabdomyolysis [23]. Mognol *et al*. suggested that rhabdomyolysis after bariatric surgery is the result of unrelieved muscle pressure while on the operating table, which leads to the development of compartment syndrome [22]. Our diabetic patient had a BMI of 60.4 kg/m^2 and the anesthetic time of 285 min. Therefore, we suggest that the levels of creatine phosphokinase [20] and potassium should be monitored in SSO patients undergoing bariatric surgery, especially when the surgical time is prolonged.

To delay tracheal extubation in obese patients was reported to increase the pulmonary clearance of residual inhaled anesthetics and enhance postoperative recovery [24]. In our study, only 40% of patients (n = 10) were extubated in the operating room at the end of surgery, which reflected the anesthesiologist's concern that increased BMI might increase the body's capacity to retain potent inhaled anesthetics that may delay airway reflex recovery [25]. MO patients often experience postoperative oxygen desaturation [26]. Furthermore, Memtsoudis *et al*. demonstrated that surgical patients with sleep apnea were at a higher risk of having perioperative pulmonary complications [27]. Although sleep apnea syndrome is a commonly encountered comorbidity in SSO patients, we found that this comorbidity does not seem to increase the frequency of oxygen supplement required when patients were discharged to the ward, corroborating the findings of a previous study [26]. In the current study, one out of the five patients with obstructive sleep apnea experienced major complication (20%) compared with 16% in all patients (4/25). Therefore, it appeared that obstructive sleep apnea was not a particularly important contributor to bariatric surgery-related complications in this study.

In our SSO patients (BMI ≥60 kg/m^2), we found that MBP did not increase significantly after abdominal insufflation compared with that during anesthetic induction [Figure 1]. The finding is different from that of a previous study that demonstrated an abdominal insufflation-induced increase in MBP in MO patients (BMI 40–60 kg/m^2) attributable to elevated systemic vascular resistance [28]. Whether a higher BMI in our patients contributed to the discrepancy in results remains to be elucidated.

This study had several limitations in addition to those inherent to all retrospective studies. First, the small size of the patient population in this study (n = 25) precluded adequate performance of statistical analysis on the possible association between perioperative complications (or outcomes) and abnormal data (or examinations) due to the presence of various confounders (e.g., depth of anesthesia, BMI, and smoking history). Second, we did not have data on pulmonary function tests and apnea–hypopnea index in all patients so that the prevalence of obstructive sleep apnea may be underestimated. Third, the incidence and type of postoperative complications may vary with patient selection, experience of the anesthesiologists, and operating surgeons as well as the laparoscopic bariatric surgical approaches being chosen. Finally, we did not have a long-term (>30 days) follow-up of outcomes after bariatric surgery.

Conclusions

When dealing with SSO patients undergoing laparoscopic bariatric surgery, it is imperative to anticipate the potential for their development of perioperative adverse events and postoperative complications. Taking into account the relatively high incidence of early postoperative complications, loosening of the criteria for postoperative intensive care may be considered in this patient population.

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Conflicts of interest

There are no conflicts of interest.

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