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CLINICAL REPORT

Anesthesia for a 228-kg patient (body mass index, 90.6) undergoing laparoscopic sleeve gastrectomy

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Abstract We undertook anesthesia of a 40-year-old woman with body weight of 228 kg and body mass index (BMI) of 90.6 kg/m^2 who was undergoing laparoscopic sleeve gastrectomy. This case may be the largest known patient undergoing general anesthesia in our country. Anesthesia was induced in a 30° head-up position with midazolam, fentanyl, droperidol, and inhalation of sevoflurane and nitrous oxide without muscle relaxants, and maintained with propofol, remifentanil, and pancuronium under pressure-controlled ventilation. The Airway Scope could not be inserted into her mouth, but her trachea was successfully intubated with a Macintosh laryngoscope. Dosages of anesthetics and fluid infusion rate were calculated first per ideal body weight. Then, infusion of propofol and remifentanil and administration of muscle relaxant were controlled by bispectral index, hemodynamics, and train-of-four response, respectively. Postoperative 12-h pressure-controlled ventilation and pain management by subcutaneous infusion of fentanyl and droperidol were successful. Subcutaneous heparin 5,000 units twice per day postoperatively did not induce thromboembolism.

Keywords Bariatric surgery · Super-obese · General anesthesia · Intravenous anesthetics

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Introduction

Morbid obesity is defined as a body mass index (BMI) > 35 kg/m^2 and super obesity as BMI > 55 kg/m^2 [1]. Anesthesia for such patients poses many problems, e.g., in ventilation, intubation, oxygenation, selection of anesthetics, and postoperative pain management. We experienced a super-obese case weighing 228 kg with BMI 90.6 kg/m^2 undergoing laparoscopic sleeve gastrectomy, which case may be the largest known patient undergoing general anesthesia in our country.

Case report

A 40-year-old woman of height 158.6 cm, weight 228 kg, and BMI 90.6 kg/m^2 was scheduled for laparoscopic sleeve gastrectomy. Ideal body weight of this patient was 55.3 kg calculated as height (m)^2 × 22. She had sleep apnea, requiring continuous positive airway pressure (CPAP) at night, diabetes mellitus well controlled with oral medication, and an allergy for penicillin and aspirin. She had also an endometrial cancer. However, because of her obesity, she could not undergo surgery for endometrial cancer. Therefore, it was judged to perform bariatric surgery first. She received a very low calorie diet of 800 kcal per day for 2 months and decreased her weight by 22 kg before surgery. Her preoperative laboratory data showed abnormal values only in C-reactive protein (CRP, 2.4 mg/dl), uric acid (7.7 mg/dl), and PT-INR (prothrombin time-international normalized ratio, 1.18). Blood gas analysis was pH 7.38, $PaCO_2$ 46.4 mmHg, PaO_2 71.2 mmHg, and HCO_3^- 26.9 mmol/l in room air. Mallampati airway classification was III. Chest X-ray showed extended rib cage transversely. ECG, echocardiography, and respiratory function

were in normal ranges. No venous thrombus in the lower extremities was observed by ultrasound. She could walk by herself in the ward, but for long distances she used a specially made wheelchair.

Without any premedication, she walked into the operating room. Anesthesia was induced on the operating table, already positioned at 30° head up. Oxygen saturation (SpO_2) was 93% in room air. Three anesthesiologists anesthetized this patient. Besides the conventional Macintosh laryngoscope, McCoy's laryngoscope, Airtraq, Airway Scope, a fiberscope, bougie, and emergency tracheostomy kit were prepared. Under inhalation of oxygen 6 l/min by a mask and preparation of naloxone and flumazenil, anesthesia was induced with midazolam 5 mg (0.09 mg/ideal body weight) and fentanyl 100 μg (1.81 μg/ideal body weight). As she made an involuntary movement, droperidol 5 mg (0.09 mg/ideal body weight) and inhalation of sevoflurane 8% and nitrous oxide 4 l/min in oxygen 4 l/min were added. One anesthesiologist maintained the airway and another pressed the bag to ventilate. When the bispectral index (BIS) decreased to 60, orotracheal intubation with a clear endotracheal tube (internal diameter, 7.5 mm) was performed. Airway Scope (Pentax, Tokyo, Japan) insertion was tried first, but it was difficult to insert it into her small mouth. Then, a Macintosh blade No. 3 was successfully used for intubation. The Cormack and Lehane classification was 3. After intubation, rocuronium 50 mg (0.9 mg/ideal body weight) was administered, and propofol 320 mg/h (5.78 mg/ideal body weight/h) and remifentanil 1 mg/h (0.018 mg/ideal body weight/h) were started. The infusion rate of propofol was controlled to keep BIS between 40 and 60, resulting in 400–700 mg/h (7.23–12.66 mg/ideal body weight/h). The infusion rate of remifentanil was adjusted to keep systolic blood pressure between 90 and 120 mmHg and heart rate between 60 and 90 beats/min, resulting in 0.5–1 mg/h (0.15–0.30 μg/ideal body weight/min). Pancuronium 2 mg (0.036 mg/ideal body weight) was administered when the first twitch was observed by train-of-four response, which resulted in a 30-min interval from the first rocuronium to pancuronium and a 45- to 60-min interval thereafter. Subcutaneous infusion of fentanyl 25 μg/h and droperidol 0.2 mg/h was started 2 h before the end of surgery and continued for 24 h.

Ventilation was performed to keep end-tidal carbon dioxide tension between 40 and 45 mmHg with pressure control [pressure limit, 14–30 cmH_2O, positive end-expiratory pressure (PEEP) 5 cmH_2O, inspiratory flow 30–35 l/min, respiratory rate 12–17 breaths/min, 100% oxygen). Blood gas analysis was pH 7.35, PaO_2 127 mmHg, and $PaCO_2$ 46.8 mmHg before the start of surgery, and pH 7.31, PaO_2 260 mmHg, and $PaCO_2$ 53.9 mmHg at the end of surgery (F_IO_2 1.0 in both measurements). Pneumoperitoneum was performed with 12–15 mmHg for 6 h. Acetated Ringer solution with 1% glucose 5,200 ml (10.2 ml/ideal body weight/h) was infused. Blood glucose was in the range of 90–150 mg/dl; blood loss was 1,000 ml; urine volume was 670 ml (1.31 ml/ideal body weight/h). Duration of surgery was 435 min and that of anesthesia was 555 min.

Her lungs were continuously ventilated after surgery in the intensive care unit with pressure-controlled synchronized intermittent mandatory ventilation (F_IO_2 0.8, PEEP 5 cmH_2O, pressure support 28 cmH_2O, respiratory rate 14 breaths/min) under sedation with midazolam 20 mg/h (0.3 mg/ideal body weight/h) to keep the observer's assessment of alertness/sedation (OAAS) at scale 3 or 4. Her trachea was extubated 12 h after admission to the intensive care unit, 2 h after stopping midazolam infusion. Blood gas analysis before extubation was pH 7.41, PaO_2 227 mmHg, $PaCO_2$ 41 mmHg (F_IO_2 0.8); that after extubation was pH 7.38, PaO_2 63.3 mmHg, $PaCO_2$ 46.4 mmHg (F_IO_2 0.4 10 l/min). Acetated Ringer solution with 1% glucose was infused at 80 ml/h (1.45 ml/ideal body weight/h). Urine volume was >40 ml/h (0.72 ml/ideal body weight/h). Blood glucose was in the range of 80–120 mg/dl. Heparin 5,000 units was subcutaneously administered twice daily after surgery. She started to walk, and was discharged from intensive care unit to the ward on the next day after surgery and from the hospital 1 week later without any complications.

Discussion

Anesthesia for these super-obese patients has many problems, especially in airway management, choice and dose of anesthetics, fluid management, and postoperative analgesia.

Our management plan for this patient was (1) preoperative weight loss by diet, (2) anesthesia by three anesthesiologists, (3) anesthesia induction in a head-up position with intravenous anesthetics that are reversible and without muscle relaxants, (4) calculation of doses of anesthetics and fluid infusion speed by ideal body weight at first, (5) preparation of all devices for difficult intubation, (6) anesthesia maintenance with intravenous anesthetics controlled by bispectral index and hemodynamics, (7) pressure-controlled ventilation, (8) postoperative heparin for prevention of venous thrombus, (9) and postoperative analgesia by subcutaneous fentanyl.

Anesthesia induction of morbidly obese patients in a 30° head-up position, as in this case, improves laryngoscopic view, increases well-tolerated apneic time by relieving pressure on the diaphragm from abdominal contents [2], and improves oxygenation [3].

Anesthesia was induced with midazolam, fentanyl, droperidol, sevoflurane, and nitrous oxide without muscle relaxant. Midazolam and fentanyl can be reversed

immediately with flumazenil and naloxone, respectively. However, large doses of midazolam and fentanyl risk inducing hypotension and rigidity, respectively. Therefore, small doses were administered. Sevoflurane and nitrous oxide were added to deepen anesthesia, because if we could not intubate, these agents would be excreted in expiration so that the patient could emerge from anesthesia safely by her own respiration. A small dose of droperidol was added against involuntary movement, but as this agent has few effects on hemodynamics and respiration, it could be safely used. Another choice might be propofol, but propofol causes strong respiratory depression and has no reversal agent. Therefore, we selected droperidol, not propofol.

For super-obese patients, it is difficult to determine which dose of anesthetics should be used, whether calculated by actual body weight or ideal body weight. The ideal body weight of this patient was 55.3 kg, and corrected body weight by Servin et al. [4] was 124.4 kg [ideal body weight + 0.4 × (total body weight − ideal body weight)]. Both propofol and remifentanil are highly lipophilic, with a potential for increasing and unpredictable accumulation into fat tissue. However, as remifentanil is very rapidly metabolized by unspecific esterases in blood, no accumulation in fat tissue actually occurs. Therefore, remifentanil could be administered according to ideal body weight [5]. Target-controlled infusion of propofol calculated with corrected body weight by Servin et al. [4] was successfully used in a patient of 290 kg [6]. However, in the study by Alvarez et al. [7], propofol was infused as μg/kg/min calculated by ideal body weight. Midazolam was also used as calculated by ideal body weight [7]. However, midazolam is highly lipophilic, which shows significant increase in volume of distribution for obese patients [8]. Therefore, an increased dose might be expected. No reports were found concerning the dose of fentanyl and droperidol in super-obese patients. As sevoflurane accumulates in the fat, usually it is not recommended for obese patients.

Rocuronium 50 mg induced complete muscle relaxation. This dosage is higher than that based on ideal body weight, but the duration of its effect was 30 min. Pharmacokinetic parameters of drugs with low lipophilicity such as rocuronium are not very different in obese and lean patients [9]. Rocuronium is recommended for administration according to ideal body weight in induction of anesthesia [10]. Rocuronium when administered by total body weight results in more than doubling of the duration of action when compared with doses based on ideal body weight [11]. We administered pancuronium for maintenance of muscle relaxation because of the long duration of surgery but under careful monitoring of neuromuscular block. There are no data concerning dosage of pancuronium in super-obese patients.

Because of the patient's super obesity, small mouth, and Mallampati classification III, difficult intubation was suspected. Therefore, we prepared all the devices for difficult intubation in our hospital. Awake intubation is one of the choices in such cases. However, if this super-obese patient struggled, not only intubation but also keeping her on the operating table might be difficult. Therefore, we selected deep anesthesia. We first tried intubation with Airway Scope but it failed because of her small mouth. Then, intubation was successful by a conventional Macintosh laryngoscope while Cormack and Lehane classification was 3. Neither obesity nor BMI predicted difficult intubation, whereas the high Mallampati classification (3) increased the potential for difficult laryngoscopy and intubation [12].

Pressure control ventilation was used in this patient. Pressure-controlled ventilation uses decelerating inspiratory flow, which generates higher instantaneous flow peaks and may allow a better alveolar recruitment. Pressure-controlled ventilation improves oxygenation without any side effects [13]. Peak inspiratory airway pressure was significantly lower during pressure-controlled ventilation than during volume-controlled ventilation, although Hans et al. [14] reported that PaO_2 and $PaCO_2$ were not different between these methods in morbidly obese patients. We used 5 cmH_2O PEEP in this patient under 15 mmHg pneumoperitoneum pressure. Valenza et al. reported that the optimum PEEP might be 10 cmH_2O to counteract pneumoperitoneum in "beach chair" position [15]. However, they did not show the pneumoperitoneum pressure.

For postoperative analgesia, we selected subcutaneous infusion of fentanyl and droperidol. We considered it difficult to place an epidural catheter in this patient because she was super obese and postoperative heparin was required to prevent venous thrombus. Intravenous fentanyl is thought to be dangerous when an unexpected bolus administration occurs. Therefore, we chose the subcutaneous route although we did not know how effective fentanyl was with this route. Droperidol was added to prevent nausea by fentanyl. With our regimen, analgesia at rest was obtained, and no side effects occurred.

We administered heparin after surgery only for prevention of thrombus because no apparent thrombus was observed by ultrasound before surgery. She walked on the next day after surgery. She had no symptom of thromboembolism after surgery. Adequate venous thromboembolism prophylaxis is achieved using calf-length pneumatic compression devices, early ambulation, and relatively short operative times. Pharmacological anticoagulation is not mandatory when these conditions are met in patients who have no early history of venous thromboembolism [16]. We applied calf-length pneumatic compression devices and early ambulation, but because of the long duration of surgery we added heparin after surgery.

In conclusion, we successfully treated a 228-kg woman for laparoscopic sleeve gastrectomy by anesthesia with propofol and remifentanil administered according to the ideal body weight, pressure-controlled ventilation, and postoperative pain control with subcutaneous fentanyl and droperidol.

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