J Anesth (2007) 21:261–264
DOI 10.1007/s00540-006-0484-8

Journal of
Anesthesia

Anesthetic management of an extremely obese patient

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Abstract
We present the case of a morbidly obese woman, with a body mass index (BMI) of 73.7 kg·m^{-2}, who had a gynecological operation under combined general and epidural anesthesia. The patient's trachea was intubated, using a fiberscope, while she was breathing spontaneously after the intravenous injection of fentanyl and propofol as sedatives. Anesthesia was maintained with intravenous propofol and epidural mepivacaine. When the gynecologist placed a sponge in the abdominal cavity to retract the bowel, the patient experienced severe arterial deoxygenation and mild hypotension, due to massive atelectasis of the left lung. Both oxygenation and perfusion were corrected by the removal of the sponge and with the placement of a pillow under the patient's left shoulder. The atelectasis resulted from compression of the left lung by the fatty mediastinum and by the diaphragm being pushed up by the sponge. The hypotension resulted from impaired venous return and hypoxia. The patient suffered no perioperative complications other than atelectasis and a surgical-site infection. Key factors that contributed to the favorable outcome of this patient included a careful tracheal intubation technique, the choice and dose of anesthetic agents, immediate correction of the factors leading to atelectasis, early ambulation, and prophylaxis for deep vein thrombosis.

Key words Extreme obesity · Massive atelectasis · Total abdominal hysterectomy · General and epidural anesthesia

Introduction

Obesity is described by the body mass index (BMI). This index is derived by dividing the body weight in kilograms by the square of the height in meters. Obesity and morbid obesity are defined as a BMI of more than 30 and 35, respectively. A BMI of greater than 40 denotes extreme obesity [1]. Obesity raises the risk of diseases in nearly every organ system, with a notable increase in the risk of pulmonary embolism. Thus, when an obese individual undergoes surgery, careful anesthetic management is necessary. Our case report describes the anesthetic management of a Japanese woman with a BMI of 73.7 who presented for gynecological surgery. In Japan, obesity of this magnitude is unusual, and the anesthetic management of such a patient has not yet been reported in the Japanese literature. Because problems concerning respiration during anesthesia and surgery in this patient were a direct result of obesity, we report this case.

Address correspondence to: Y. Sai
Received: April 5, 2006 / Accepted: November 10, 2006

Case report

The patient, a 43-year-old Japanese woman, 155 cm tall, weighing 177 kg, was undergoing a total abdominal hysterectomy and adnexectomy for stage Ia endometrioid adenocarcinoma. She had no history of hypertension. She did admit to shortness of breath with minimal exercise; however, she could walk with the aid of a walker. The patient suffered from sleep apnea syndrome, with apnea resulting in desaturation to an arterial oxygen saturation (Sp_{O_2}) of 60% occurring about 25 times per hour while she was asleep. She had no difficulties in extension and flexion of her neck, and opened her mouth about 4 cm between the upper and lower incisors. The Mallampati class of her airway was class II. Her fasting blood glucose level was within normal limits, but her oral glucose tolerance test revealed mild glucose intolerance (100 mg·dl^{-1} before the test, 207 mg·dl^{-1} after 60 min, and 103 mg·dl^{-1} after 120 min). Her arterial blood gas values in room air were: pH, 7.43; Pa_{CO_2}, 45 mmHg; Pa_{O_2}, 72 mmHg; base excess (BE), 5.1 mEq·l^{-1}. A chest radiograph showed no abnormality other than mild cardiomegaly. ECG and echocardiography were essentially normal. The patient was not

currently on any medication. She had tried dieting before the operation, which resulted in a weight loss of 3 kg.

One week prior to the surgery, the gynecologists, anesthesiologists, and operating room and intensive care unit (ICU) nurses, and the patient met in the operating room to discuss the practical problems likely to be encountered during the operation. Of concern was whether the operating table was wide enough for the patient her tolerance for the supine position; the kind of pillows needed to support her back, arms, and legs; and how to transfer her from the operating table to the ICU bed after the surgery. The day before the operation an epidural catheter was placed, under fluoroscopic guidance, in the T10-11 space, with the patient in the seated position. The distance from the skin to the epidural space was 10 cm.

Intraoperative monitoring included the following: ECG, noninvasive and invasive blood pressure, temperature, urine output, pulse oximetry, capnometry, bispectral index (BIS), and neuromuscular blockade (TOF monitor). General anesthesia was induced with incremental intravenous (IV) doses of fentanyl in 25- to 50-μg increments, to a total of 200 μg, and a 20-mg bolus dose of propofol injected intravenously, followed by continuous infusion at the rate of $2\,mg{\cdot}kg^{-1}{\cdot}h^{-1}$. Oral tracheal intubation with a 7.5-mm internal diameter (ID) endotracheal tube was accomplished using a fiberscope under topical anesthesia with 4% lidocaine, with the patient breathing spontaneously. Anesthesia was maintained with IV propofol, $640–800\,mg{\cdot}h^{-1}$ ($3.6–4.5\,mg{\cdot}kg^{-1}{\cdot}h^{-1}$), and epidural 1% mepivacaine, at incremental doses of 2–4 ml, resulting in BIS values of 45–60. After intubation, the patient was paralyzed with a bolus of 4 mg vecuronium and her respiration controlled. Paralysis was maintained with 2-mg topups, as indicated by neuromuscular monitoring, with additional doses being required almost every 30 min. We observed that the patient's airway pressure was so high that a tidal volume of 700–800 ml was achieved only by increasing the peak inspiratory pressure (PIP) to 40 cm H2O. Under pressure-controlled ventilation of 40 cm H2O and a respiratory rate of 10 breaths min^{-1}, the arterial blood gas values were: pH, 7.37; P_{CO_2}, 44 mmHg; P_{O_2}, 154 mmHg; BE, $0.1\,mEq{\cdot}l^{-1}$ (fraction of inspired oxygen [$F_{I_{O_2}}$], 0.6).

The deposit of fat in the patient's upper abdomen was so large that it descended to cover the lower abdomen, obstructing the surgical site and necessitating the removal of approximately 10 kg of fat before the performing of the main procedure (Fig. 1). Surgery proceeded uneventfully for about 2 h until the gynecologist placed a sponge in the abdominal cavity to retract the bowel. The $S_{p_{O_2}}$, which had so far been maintained above 95%, suddenly dropped to 80%, with an accompanying decrease in blood pressure to 80 mmHg. Arterial blood gas measurements at this time were: pH, 7.41; P_{CO_2}, 40 mmHg; P_{O_2}, 50 mmHg; BE, $0.4\,mEq{\cdot}l^{-1}$ ($F_{I_{O_2}}$, 1.0). Removal of the sponge resulted in gradual improvement of the $S_{p_{O_2}}$ values to 90%. Auscultation of the patient's chest demonstrated an absence of respiratory sounds over her left lung. A chest X-ray was immediately obtained to rule out tension pneumothorax as a cause of the desaturation and hypotension. The chest X-ray revealed diminished radiolucency over the entire left lung field, suggestive of massive atelectasis (Fig. 2). Examination of the patient's airway by bronchofiberscopy showed no secretions, but the orifice of the left main bronchus was flattened out. A 5-cm-high pillow was immediately placed below her left shoulder, and this resulted in rapid improvement of the $S_{p_{O_2}}$, to 100%. The gynecologists stopped using a sponge for retraction and instead extended the abdominal incision to obtain a wider surgical field. The remainder of the surgery proceeded uneventfully until the patient was transported to the ICU while still intubated. When the patient was transferred to the

Fig. 1. Photograph of the patient before surgery. The deposit of fat in her upper abdomen was so large that it descended to cover the lower abdomen

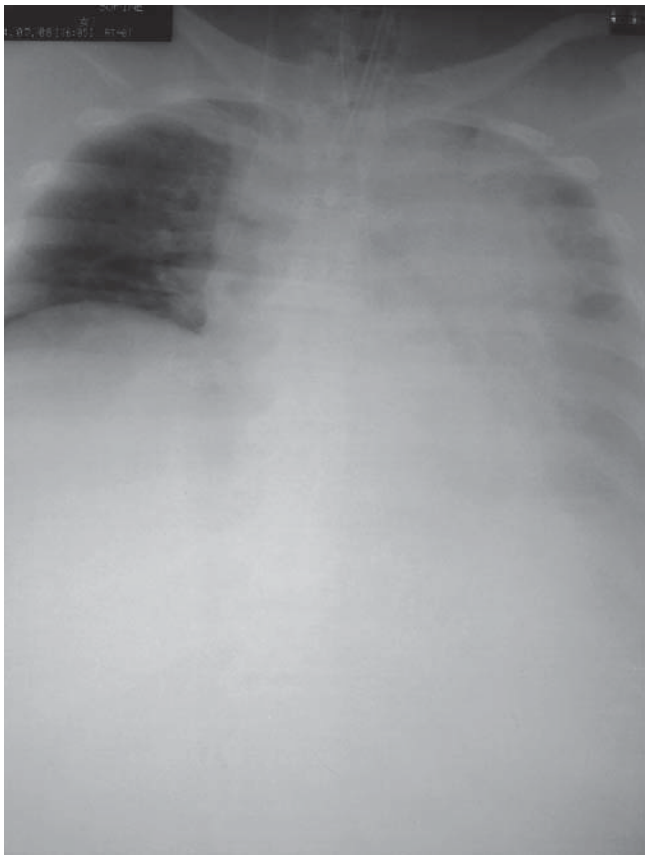

Fig. 2. Chest X-ray film during surgery when hypoxemia and hypotension occurred. Note massive atelectasis in the left lung

ICU bed, she desaturated. A pillow was placed below her left shoulder, which once again resulted in an improvement in her S_{PO_2}.

In the ICU, the patient was managed by artificial ventilation in the seated position, propped up with big pillows that prevented her from leaning to the side. Under pressure-controlled ventilation of 24 cm H2O with the same pressure support, a respiratory rate of 16 min^{-1} and 8 cm H2O positive end-expiratory pressure (PEEP), her arterial gas values were: pH, 7.30; P_{CO_2}, 47 mmHg; P_{O_2}, 138 mmHg; and BE, –3.9 $mEq \cdot l^{-1}$ breathing 100% oxygen. She was extubated the next morning onto bilevel positive airway pressure (BiPAP) and was soon transferred to continuous positive airway pressure (CPAP) management with a face mask. Under CPAP of 4 cm H2O on 40% inspired oxygen, her arterial gas analysis was: pH, 7.33; Pa_{CO_2}, 56 mmHg; Pa_{O_2}, 93 mmHg; and BE, 2.3 $mEq \cdot l^{-1}$. On the second postoperative day, she was encouraged to mobilize and on the third day she was discharged from the ICU. The atelectatic area in her left lung had completely disappeared. To prevent the formation of a deep vein thrombosis, intermittent pneumatic foot compression was used from the beginning of the operation until ambulation in the ICU, and heparin sodium was intravenously infused at the rate of 15 000 $U \cdot 24\,h^{-1}$ from about 1.5 h before the end of the operation to her discharge from the ICU. To relieve postoperative pain, mixed bupivacaine and buprenorphine solutions were administered through the epidural catheter, with supplemental bolus doses of local anesthetics.

Discussion

Despite being extremely obese, this patient had no medical problems other than obstructive sleep apnea and mild glucose intolerance. In obese patients, the expiratory reserve volume (ERV) and functional residual capacity (FRC) are markedly decreased, and this loss in lung capacity is magnified under general anesthesia [2,3]. Under anesthesia, the heavy weight of the torso overcomes the normal expansive tendency of the rib cage and the abdominal contents push against the diaphragm. This results in atelectasis and a mismatch of the ventilation-perfusion ratio, and consequently, hypoxemia [4].

Our anesthetic plan for this patient focused on preventing hypoxemia and pulmonary embolism. Key aspects included an early extubation, nursing in a sitting or semi-sitting position postoperatively, and early ambulation. We chose to include epidural anesthesia as an adjunct to general anesthesia, because it would not only reduce the general anesthetic requirement but would also provide postoperative pain relief with minimal respiratory depression.

Obesity predisposes to a difficult intubation [5]. In order to avoid having to control ventilation via the face mask or risk losing the airway altogether, we intubated the patient's trachea while she was breathing spontaneously. After intubation, we were able to obtain a tidal volume of 700–800 ml only by increasing the PIP to 40 cm H2O. This illustrates the danger associated with inducing respiratory cessation with muscle relaxants in an obese patient, prior to gaining adequate control of the airway.

After induction, anesthesia was maintained with IV propofol and epidural mepivacaine. Propofol was selected as the main anesthetic agent because it permitted rapid awakening with minimal residual sedative effects, thereby decreasing the need for artificial ventilation postoperatively. It also carried a low risk of postoperative nausea and vomiting [6].

Arterial oxygenation tends to significantly decrease during anesthesia and surgery in morbidly obese patients. To improve oxygenation, ventilation with PEEP or large tidal volume ventilation has been suggested [7,8]. These, however, have not been shown to be con-

sistently effective, and may in fact worsen oxygenation [9,10]. It is likely that an increased alveolar pressure increases the shunt fraction. We attempted to improve the patient's oxygenation by altering the tidal volume and level of PEEP; however, neither intervention was effective.

Despite our careful preparation to prevent pulmonary complications, we still encountered arterial desaturation and hypotension during the operation, that resulted from massive atelectasis. Considering that no secretions were found in her airway, that the orifice of the left main bronchus was flattened, and that placing a pillow under her left shoulder improved the oxygenation, the atelectasis was most likely due to positional compression of the left lung and bronchus. The left lung was compressed by the fatty mediastinum and the diaphragm, which was pushed up by the abdominal viscera and sponge. The pillow shifted the patient from the supine to a right decubitus-like position, thereby displacing the fatty mediastinum to the right and decompressing the left lung and bronchus. The hypotension was likely caused by a combination of impaired venous return, secondary to placing the sponge, and hypoxemia which accompanied the atelectasis. We realized that, in an extremely obese patient undergoing general anesthesia in the supine position, the risk of respiratory compromise is so great that placing a sponge in the abdominal cavity and pushing up on the diaphragm is imprudent. Likewise, the Trendelenburg position should never be used in such patients [11]. Should atelectasis occur, it is imperative to rapidly remove the sponge, or anything compressing the diaphragm, and attempt to change the patient to a semi-decubitus position. The consequence of every surgical maneuver must be carefully considered in the obese patient, because even something as trivial as placing a sponge to improve visibility could result in significant respiratory compromise. The development of massive atelectasis prevented us from meeting our objective of extubating the patient in the operating room. The atelectasis persisted until the patient ambulated in the ICU. Management in a sitting or semi-sitting position and early mobilization postoperatively were instrumental in preventing more serious pulmonary complications.

Both hypertension and glucose intolerance frequently complicate obesity [4]; thus, it is prudent to titrate anesthetics to prevent either hypotension or hypertension, and frequently monitor blood glucose. The patient's blood pressure and heart rate were generally stable throughout the surgery except at the point that atelectasis occurred, and blood glucose values were not high enough to use insulin.

The patient suffered no perioperative complications other than atelectasis and a surgical-site infection. Key factors that contributed to the favorable outcome of this patient included a careful tracheal intubation technique, the choice and dose of anesthetic agents, immediate correction of the factors leading to atelectasis, early ambulation, and prophylaxis for deep vein thrombosis.

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