Case Report

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Anesthesia For Patients Receiving Single-Lung Transplantation in Non-Pulmonary Surgical Intervention: A Case Report

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Abstract:

With improvements in the survival rate following lung transplantation, lung transplant recipients occasionally undergo subsequent non-pulmonary surgical interventions that are not directly related to their pulmonary disease. Both anesthesia and surgical procedures can affect the transplanted lungs and other organs in such patients. Moreover, these patients may show pulmonary function impairment; depending on the type of surgery and anatomical site. An adequate understanding of the physiology of the transplanted lung, careful preoperative evaluation and preparation, appropriate utilization of airway equipment, and proper management of intraoperative fluids and ventilation are crucial for superior perioperative outcomes.

Keywords: anesthesia, non-pulmonary surgery, single-lung transplantation

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Introduction

Lung transplantation is a successful treatment of choice in patients with end-stage lung diseases. The survival rate after lung transplantation has significantly increased due to more relaxed donor selection criteria, better organ preservation, and improved perioperative and postoperative management[1]. The median survival following lung transplantation has increased from 4.7 to 6.7 years in the last decade, in comparison with survival over the previous 20 years[2]. However, with the increasing number of lung transplant patients, the need for non-pulmonary surgical interventions after transplantation has also increased. Many implications for anesthetic care are important due to the physiology of the transplanted lung and the effects of immunosuppressant agents. This article discusses the management of a single-lung transplant patient having undergone general anesthesia for non-pulmonary surgery, which may be different from other case reports.

Case report

This study was approved by the Human Research Ethics Committee, Faculty of Medicine, Prince of Songkla University, Thailand (REC.65-341-8-1), and written patient consent for publication was obtained. A 68-year-old Thai male, with idiopathic pulmonary fibrosis underwent total left-side single-lung transplantation 23 years prior to presentation. After lung transplantation, the patient was maintained with immunosuppressive medications that consisted of cyclosporine 100 mg/day, prednisolone 5 mg/day, and mycophenolate mofetil 1,250 mg/day. His other underlying diseases included hypertension and dyslipidemia.

Five months prior to this admission, he presented with a palpable abdominal mass, and computed tomography imaging studies showed a mass in the descending colon. He was subsequently scheduled for an open left hemicolectomy.

Prior to surgery, he had no respiratory symptoms, no history of rejection, nor respiratory problems; such as pneumonia. Preoperative chest radiography showed unremarkable findings related to the left lung, but a honeycomb appearance with traction bronchiectasis was observed in the right lung. Preoperative chest x-ray: Figure 1.

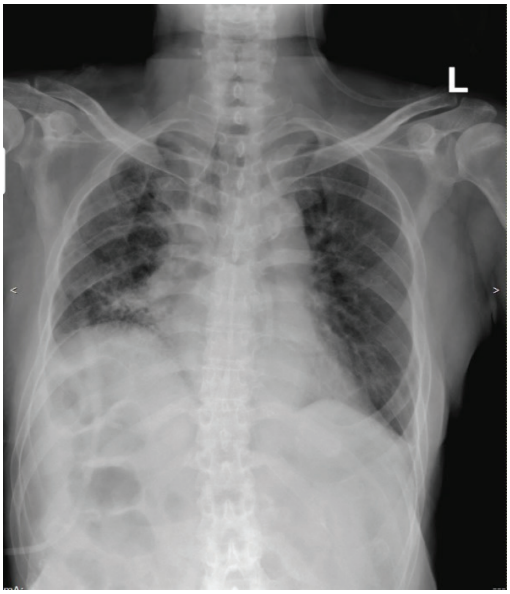

Figure 1 Preoperative chest X-rey

Preoperative pulmonary function tests (PFT) showed severely restrictive disease, with a functional vital capacity (VC) of 36%, forced expiratory volume in one second (FEV1.0) of 40%, and FEV1.0/FVC ratio of 82. He continued to take cyclosporine, prednisolone, and mycophenolate mofetil during the pre-medication phase. After the patient's arrival at the operating room, oral decontamination in the pre-anesthetic procedure via the povidone-iodine gargle was performed to prevent respiratory contamination. Combined anesthesia (epidural-general) has been used in these patients due to major abdominal surgery. An epidural catheter was inserted at the T8/9 level while the patient was awake, followed by induction of anesthesia with fentanyl (100 µg), propofol (70 mg), and cisatracurium (8 mg).

Intubation was performed using a single-lumen, with an internal diameter of 8 mm. Anesthesia was maintained with cisatracurium and 4%-7% desflurane in air and oxygen, and 2% lidocaine with adrenaline was continuously infused via the epidural catheter. Lung protective ventilation was used with a pressure control mode of 16-17 cmH_2O for peak inspiratory pressure (PIP) (tidal volume of about 300 mL), a respiratory rate of 14 bpm, and positive end-expiratory pressure (PEEP) of 5 cmH_2O were provided to protect the transplanted lung. During the operation, airway pressure was cautiously monitored, because a double-lumen tube was not inserted. The direct intra-arterial pressure, with stroke volume variation and cardiac output, was monitored. This was the same approach performed for the evaluation of pulse oximetry, arterial blood gas, body temperature, and end-tidal carbon dioxide tension. The intraoperative arterial blood gas analysis was as: pH 7.37, $PaCO_2$ 41.7 mmHg, PaO_2, 178 mmHg, HCO_3 23.7 mEq/L, and 98% O_2 saturation (SaO_2), with a fraction of inspired oxygen (FiO_2) of 0.4. The total operating time was 5 hours and 5 mins, the estimated blood loss was 200 mL, and the total fluid intake was 750 mL of Ringer's lactate solution. The intraoperative urine output was 50-100 mL/h. At the end of the surgery, the patient was extubated under spontaneous ventilation, with a tidal volume of at least 300 mL, and while fully awake. A solution of 2 μg/mL fentanyl and 0.1% levobupivacaine was continuously infused at 5 mL/h for postoperative analgesia for two days. The patient received immunosuppressive agents throughout the perioperative period as an oral regimen due to fasting for 24 hours. In contrast, if the patient was unable to take oral immunosuppressive agents after surgery for a long time, consideration should be given to intravenous administration. The patient was discharged four days after surgery without postoperative complications. No complications were observed at one month after surgery. The pathology of the colonic mass was diverticulosis with diverticulitis and negative for malignancy.

Discussion

Recently, lung transplantation has become the final choice for the treatment of end-stage respiratory diseases. The patient must receive immunosuppressive agents, as both induction and maintenance therapy after lung transplantation. Unfortunately, these medications are associated with a higher incidence of hypertension, diabetes, osteoporosis, renal dysfunction, and malignancy. The rates of development of hypertension and diabetes are 82.9% and 40.5%, respectively, within 5 years of lung transplantation[3,4]. Moreover, the success of lung transplantation has improved over time, and the patient now has a better chance of long-term survival and functional outcomes. Furthermore, the need for surgical intervention for non-pulmonary conditions has increased. Intra-abdominal conditions are the most common reason for surgical procedures[5]. The prevalence of abdominal procedures among lung transplant recipients has been shown to be as high as 21%, with bowel obstruction being the most common cause; followed by peptic ulcers and cholestasis[5]. Sulser et al. found that 17% of lung transplant recipients were affected by abdominal diseases requiring surgery, while 13% of patients experienced late abdominal events[6]. In the context of such surgeries, protection of the lung graft is of paramount importance, because the 5-year survival rate of recipients of cadaveric donor transplants is approximately 50%[7].

In post-lung transplant patients, preoperative assessment should include evaluation of the residual function of both the implanted graft and all other organ systems indirectly involved in post-transplant therapy. Moreover, preoperative medications, including immunosuppressive agents, antihypertensive agents, and diuretics, must be continued until the day of surgery and resumed orally as soon as possible after surgery[4,8]. Our patient received all of his medications on the day of surgery. Provided that the patient is hemodynamically stable, all induction drugs are safe for lung transplant patients. Propofol has been suggested to

be the drug of choice, while benzodiazepines should be cautioned in their usage, as early extubation is the principal goal in such cases[9]. Propofol is an acceptable intravenous anesthetic agent that allows close monitoring of cyclosporine blood levels in the postoperative period. However, it is not advisable to use high-dose opioid techniques for induction or maintenance; instead judicious use of opioids for maintenance of anesthesia is recommended. Volatile anesthetics; such as desflurane, prevent inflammation during anesthesia maintenance[10]. In addition, the use of volatile anesthetics plus short-acting opioids or propofol combined with short-acting opioids is well tolerated, minimizing significant hemodynamic instability and allowing for rapid emergence. Due to airway hyperreactivity, deep anesthesia should be maintained, because bronchodilators are ineffective in cases of repeated graft rejection[11]. The choice of muscle relaxant depends on the length of the surgical procedure and the presence of organ dysfunction. Succinylcholine is safe for short procedures. However, if there is any evidence of renal insufficiency, hyperkalemia should be considered before succinylcholine administration. Rocuronium and cisatracurium are both suitable choices and may be preferable for longer procedures; however, the recovery time associated with their use and the appropriate amount administered should be carefully considered[12]. Long-acting agents should be avoided because of the prolonged recovery time from the blockade induced by these agents. Clinical practice guidelines suggest reducing the individual dose of neuromuscular blocking agents in non-transplant procedures following lung transplantation[13]. The associated generalized reduction in muscle strength in transplant patients may play a role in the post-anesthetic recovery time in addition to postoperative ventilatory weaning. Moreover, immunosuppressive agents may interact with neuromuscular blocking agents. Impairment of renal function in some patients may also prolong the action of these agents. Residual muscle weakness in pulmonary-compromised patients is a serious complication.

Barotrauma was one of many implications for the anesthetic care of this patient during general anesthesia. In single-lung transplant recipients, the use of positive pressure ventilation (PPV) must be considered, because of differences in lung compliance between the native and transplanted lungs; such as fibrotic lung disease (the ventilation is shifted towards the transplanted lung, which may be prone to increase risk of barotrauma). In rare instances, these differences in lung compliance may require the use of independent lung ventilation via a double-lumen tube (DLT)[13]. In most cases, an ordinary anesthesia ventilator may be used, but changes in lung compliance caused by rejection or infection may necessitate a more sophisticated intensive care-type ventilator. Ideally, two ventilator machines may be required in patients with a single lung transplant to prevent hyperinflation of one lung that can cause pneumothorax in the latter. However, these effects are not observed in double-lung transplant recipients. To protect the less compliant lung, a low peak inspiratory airway pressure is desirable during PPV, with the aim of placing as little stress as possible on the bronchial or tracheal anastomosis. A low tidal volume of less than 7 mL/ideal body weight, pressure control mode, PEEP coupled with a high respiratory rate should be used. The tidal volume should be reduced to avoid hypocapnia; especially during single-lung ventilation. To avoid barotrauma in the lung, the PIP of 30-35 cmH_2O and a plateau pressure of 20-25 cmH_2O should be used. A PEEP of 5-8 cmH_2O is indicated for patients undergoing double-lung transplantation[4,14,15]. FiO_2 was used as low as possible to ensure adequate oxygenation. However, concerns regarding potential oxygen toxicity, due to high inspiratory oxygen concentrations, are unwarranted[9]. Minute ventilation can be adjusted; so as that $PaCO_2$ is maintained at a level similar to the preoperative value for a particular patient. A comparison of intraoperative $PaCO_2$ with $PetCO_2$ is useful in patients with large differences.

After undergoing single-lung transplantation 23 years ago, this patient was able to live quite normally, without any serious respiratory complications. The lung compliance for this patient was deemed to be within normal limits. As a result, it was decided to use a single-lumen tube, with an ordinary ventilator; which was a part of the anesthetic machine. However, in the eventuality of hyperinflation of the transplanted lung, DLT and another ventilator machine were also prepared to provide differential lung ventilation. The ventilator setting was set at pressure-controlled ventilation to protect the graft to the use of a low tidal volume being less than 7 mL/kg, with a PIP of less than 30 cmH_2O. Propofol was administered for induction; whereas, maintenance involved fentanyl, cisatracurium, and desflurane. At the end of the surgery, the patient was extubated and did not experience postoperative respiratory failure.

Fluid management in the peri-operative period should maintain a careful fluid balance, due to altered lymphatic drainage in the transplanted lung may cause interstitial fluid accumulation. Accordingly, the inappropriateness of volume management in this patient was a considered factor. Perioperative goal-directed hemodynamic therapy (GDT) should be used as a treatment strategy to optimize cardiovascular dynamics. This is achieved by supplementing fluids, vasoconstrictors, and positive inotropic agents to physiologic target values of predefined hemodynamic variables[16]. For this case, we used dynamic index SVV to predict fluid responsiveness, cardiac output (CO) monitoring to determine tissue perfusion, guide hemodynamic therapy, maintained adequate urine output (0.5-1 mL/kg/hr) and mean blood pressure of more than 65 mmHg. The patient had no pulmonary complications after surgery.

In such cases, postoperative care can be provided in the recovery unit, intensive care, or ward; depending on the surgery and the patient's condition: isolation is not required. However, provision of good analgesia is important; especially when the surgery may affect pulmonary function (upper abdomen and thorax). To this end, local anesthesia, epidural and intrathecal opioids, and patient-controlled analgesia can all be used. Care must be taken to prevent respiratory depression. Monitoring oxygen saturation, either in a step-down unit or the ward, is warranted. Furthermore, patients should be encouraged to cough. Physiotherapy and incentive spirometry are important, as is postural drainage when indicated. Finally, evidence of infection or rejection should be actively and attentively sought, and such complications should be treated vigorously.

Conclusion

General anesthesia and regional anesthesia can be safely delivered to this group of patients. The single-lumen tube is also safe in patients receiving single-lung transplantation. However, barotrauma should be avoided due to differences in lung compliance between the native and transplanted lungs.

Conflict of interest

No conflict of interest.

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