Anesthetic Challenges in Patients After Lung Transplantation

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Abstract

Introduction: Recipients of lung transplants have subsequently undergone various surgical procedures unrelated to their pulmonary disease and may have anesthetic problems. Case presentation: Fifty-nine-year-old male, status post single lung transplant due to pulmonary fibrosis. He presented for laparotomy due to ischemic colitis. Induction of general anesthesia was rapid sequence. Invasive monitoring was inserted in the radial artery and internal jugular vein. Ventilation was with pressure controlled mode.Discussion: The administration of general anesthesia to patients after lung transplantation will be influenced by the degree of dysfunction exhibited by the transplanted lung, as well as the remaining native lung. The loss of afferent and efferent innervation distal to the bronchial anastomosis results in the loss of the cough reflex and neurally mediated changes in airway bronchomotor tone. The basic goal of ventilation is to ensure adequate oxygenation and ventilation while minimizing peak airway pressures. Pressure-cycled ventilation is the preferred method.

INTRODUCTION

Recipients of lung transplants have subsequently undergone various surgical procedures unrelated to their pulmonary disease and may have anesthetic problems. This presents a lot of challenges to the anesthesiologist and emphasizes the importance of a careful preoperative assessment of the pulmonary status.

Gastrointestinal complications have long been recognized as potential causes of significant morbidity and mortality in lung transplants when compared to other solid organ recipients.[1] Types of abdominal complications range from gastroparesis to viscous perforations. One study noted the overall incidence of abdominal complications at 51%, with 18% requiring surgery while 63% resulted in death. Colonic perforation seems to be particularly problematic in this population.[2]

CASE PRESENTATION

Fifty-nine-year-old male patient s/p left total single lung transplant due to idiopathic pulmonary fibrosis. His past medical history included gastroesophageal reflux disease with no history of diverticulitis. One month after the lung transplantation he presented with ischemic colitis and megacolon. He was subsequently scheduled for urgent exploratory laparotomy.

On examination his lung was clear to auscultation bilaterally. Oxygen saturation on NC 4 L/min was 93%, heart rate 110/minute, and blood pressure 110/66. Laboratory data included arterial blood gas (ABG) on room air 7.44/44/59/30/88%, sodium 134 mmol/L, potassium 5.2 mmol/L, BUN 29 mg/dl, creatinine 0.6mg/dl, glucose 101 mg/dl, WBC 7540, hemoglobin and hematocrit 12 g/dl and 36.9 %, and platelets count 220 k/ul. Transthoracic echocardiography, which was done before the lung transplant, showed normal ejection fraction and grade 1 diastolic dysfunction consistent with impaired relaxation and normal dobutamine stress echocardiography. A computed tomography chest scan done two weeks after the transplant surgery showed bilateral pleural thickening, interstitial reticular infiltrates, with cystic changes present throughout the right lower lobe and ground glass in both lower lobes.

Pulmonary function tests before the lung transplant showed severe restrictive physiology indicated by reduced TLC 2.58 (39%), RV 1.22 (53%), and severely reduced DLCO. After the transplant and one week before the exploratory laparotomy, the pulmonary function test still showed restrictive physiology.

No premedication was given. Induction of general anesthesia was rapid sequence with midazolam 2 mg, lidocaine 60 mg,

propofol 80 mg, fentanyl 150 mcg, and succinylcholine 160 mg. Invasive monitoring was obtained at the left radial artery and right internal jugular vein. Maintenance of anesthesia using a mixture of Air/O2 with flows 1 L/1 L, desflurane and muscle relaxation maintained with rocuronium. Ventilation was with a pressure controlled mode of 24 cm/H2O, respiratory rate 10, PEEP 5, FIO 2 0.54 to 0.46, minute ventilation 8 L/min, I:E ratio 1:2. Arterial blood gases were PH 7.45, PaCO2 34, PaO2 128, BE 0, Bicarbonate 23, hemoglobin and hematocrit 9.8/30%, sodium 130 mmol/L, potassium 4.1 mmol/L, lactic acid 1.5. Surgery lasted around three hours and the estimated blood loss was 300 cc while urine output was 450 ml. We gave 1.5 L lactated ringers, 1 L albumin 5%. The patient was found to have left upper quadrant necrotic tissue, which was diagnosed as ischemic colitis and megacolon requiring subtotal colectomy and loop end-ileostomy.

Tissue collected was positive for E. coli, Klebsiella, and Clostridium. At the end of the surgery he was transported, while intubated, to the Surgical Intensive Care Unit (SICU). Patient had a complicated postoperative course with difficulty weaning off the ventilator. The patient was continued on immunosuppression therapy. He also had a transbronchial biopsy that showed no rejection or infection. He had tolerated the first three days all the way up to the point where it was felt that he was tolerating CPAP well, but then suffered decreased oxygenation with CO2 retention. He was put back on pressure support then successfully extubated three weeks after surgery and remained extubated without difficulty. Ten days later he was discharged to a skilled nursing facility in stable condition.

DISCUSSION

Colonic complications have long been recognized as a potential cause of significant morbidity in lung transplant recipients when compared to other solid organ recipients.[1] Various studies have reported the rates of colonic perforations following lung transplant as ranging from 1% to 7%, with mortalities up to 100%.[2] It has been demonstrated that as much as 40% of lung transplant recipients can have gastrointestinal symptoms after transplantation.[3]

In the first few days after the transplant, the acute effects of anesthesia, narcotics, inotropic agents and electrolyte shifts can lead to a small bowel ileus, which can present as perforation related to relative immobility, fluid shift and use of analgesics and high dose corticosteroid. Also, the incidence of gastroesophageal reflux is high.[4] Megacolon occurs early after transplant, likely secondary to narcotic medication and extensive corticosteroid use.[2]

The administration of general anesthesia to patients after lung transplantation is a great challenge and will be influenced by the degree of dysfunction exhibited by the transplanted lung as well as the remaining native lung. The native lung will probably have evidence of persisting restrictive ventilatory defects, as well as some degree of abnormal oxygenation.[5]

Allograft function may be compromised at any time by episodes of acute rejection, which are often difficult to distinguish clinically from intercurrent pulmonary infection. All but the most urgent procedure should be delayed when evidence of such reversible complications is present.[6] After SLT for chronic obstructive disease, the forced expiratory volume (FEV) in 1 second increases to 50% to 60% of the predicted value, whereas patients who have undergone SLT for restrictive disease show persistence of a mild restrictive pattern.[67]

Some of the physiological changes that occur after transplantation are independent of the pre-transplantation diagnosis. The reason for this is that the nerve supply to the transplanted lung is completely transected. The reinnervation has not been documented during the long-term follow up of heart/lung recipients.[8] Control of breathing is subtly altered after transplantation, but the changes are not clinically significant.[9] Exercise limitation has been demonstrated in a pattern compatible with a peripheral limitation to exercise that is probably related to abnormal oxygen utilization by the skeletal muscles.[10] The loss of afferent and efferent innervation distal to the bronchial anastomosis results in the loss of the cough reflex (i.e., to stimuli distal to the anastomosis) and neurally mediated changes in airway bronchomotor tone.

Airway reactivity does not appear to be increased.[11] Mucociliary clearance is impaired in pulmonary allograft, which together with immunosuppression and impaired cough, place the patient at an increased risk for perioperative pneumonia.[8] Meticulous hygiene and sterile techniques can reduce exposure of these immune-compromised patients to infectious organisms. Antibiotics should continue during the time of the operation, as should the application of immunosuppressive medications. Stress doses of steroids will be required in most cases. Hypoxic pulmonary vasoconstriction is intact in the pulmonary allograft so during an episode of rejection, pulmonary blood flow may

be directed away from the transplanted lung.[12] In patients with SLT, 60% to 70% of pulmonary perfusion is directed toward the transplanted lung.[13]

Interruption of lymphatic drainage and leaky pulmonary capillaries increases the susceptibility to pulmonary edema and warrants attention to judicious fluid administration.[5] Attention to aseptic techniques is important, as immunosuppression occurs with most chemotherapeutic drugs.

Cardiopulmonary function following transplantation is partially dependent upon the underlying disease and the type of operation. Both single and bilateral lung transplantation leads to an immediate and sustained normalization of pulmonary artery pressures and pulmonary vascular resistance.[14]

For a patient with idiopathic pulmonary fibrosis, single lung transplantation is the standard operation. The improvement in cardiopulmonary functions continues up to one year following transplantation.[7] In patients with pulmonary hypertension, single lung transplant creates a relative ventilation-perfusion imbalance between the native lung and the allograft. Because airway resistance and compliance of the native lung and the allograft are similar, ventilation is evenly divided between the two lungs. However, the preponderance of perfusion (usually greater than 80%) is directed to the allograft because of the high vascular resistance in the native lung.[15] For patients with chronic obstructive pulmonary disease, post-transplantation lung function is determined primarily by recipient factors rather than donor ones.[16] One complication following single lung transplant is progressive hyperinflation of the native lung, which can compress the allograft and compromise its function.[17]

The difference in the compliance and expiratory flow rates of a native and transplanted lung after single lung transplantation for emphysema can result in alterations in intraoperative capnography. This phenomenon has been described as producing a biphasic pattern of carbon dioxide exhalation, with the first peak reflecting exhalation from the transplanted lung and the second peak exhalation from the native lung.[18]

Some of those patients develop steroid myopathy, which is characterized by proximal weakness of the extremities. In addition, the respiratory muscles may be affected, which necessitates careful titration of the use of muscle relaxants and also in the decision of extubation. Knowledge of the underlying pulmonary pathology is essential when developing the best possible ventilation strategy. The basic goal in ventilation is ensuring adequate oxygenation and ventilation while minimizing peak airway pressures and oxygen administration. Pressure-cycled ventilation is the preferred method, allowing tight control of airway pressures to assist in preventing barotrauma. Typical parameters include a PEEP of 5 cm H2O, peak airway pressures of 20 to 25 cm H2O, and FiO2 below 0.5.[19]

Another factor limiting long-term survival of the lung is bronchiolitis obliterans, which are characterized by progressive narrowing of small airways.[19] Bronchiolitis obliterans must be considered in patients with prior lung transplantation presenting for surgery and anesthesia after the initial recovery phase. Bronchiolitis obliterans are uncommon in the first six months after transplantation, but their prevalence subsequently increases steadily and is found in 60% to 70% of patients who survive for five years.[17] In general, those patients must be treated like any other ill or immunocompromised patient.

Preoperative evaluation should include assessment of the function of the transplanted lung and other organ systems, especially those that may be compromised by immunosuppressant medications. As well, the presence of infection or rejection should be assessed. In patients with single lung transplants, careful attention should be paid to establish the extent of disease and degree of compromise of the native lung because these factors may have implications for the provision of mechanical ventilation. The nature of the patient's voice and the presence of stridor or wheezing may be clues to the presence of airway narrowing or compromise. Prolonged ventilator dependence or previous tracheostomy may indicate subglottic stenosis, thus influencing the size of endotracheal tube used or consideration of fiberoptic intubation.[20] Instrumentation of the airway may be difficult because of stenosis, as described above, which also increases the chance of infection. Some studies have recommended strict aseptic technique and the use of air filters, sterile laryngoscopes, and breathing circuits.[21]

When the patient's native lung has restrictive physiology (e.g., pulmonary fibrosis), high airway pressures will be required for expansion. Distribution of this high-pressure flow may cause barotrauma and volutrauma to the lung allograft. Differential lung ventilation, requiring the placement of a double lumen tube, should be considered.[22]

Central venous and even pulmonary artery catheters may be placed if the situation warrants. There is no evidence to suggest that cannulization of the vasculature on the side opposite the transplanted lung is safer.[22]

Opioid pain medications should be carefully monitored and judiciously used in the postoperative period. The preferred method of postoperative pain control after lung transplant is to use epidural analgesia to hasten the return of gastrointestinal function due to its sympathectomy, which allows vagal tone dominance while avoiding complications associated with systemic analgesics.[2] Incentive spirometry, chest physical therapy, postural drainage, and early mobilization are important in the postoperative period. The anesthesiologist has to be knowledgeable and able to respond to the current and future demands of this growing population of patients.

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