
CASE REPORTS

AVOIDING ECMO IN A PATIENT WITH “PUMP” LUNG POST-CARDIOPULMONARY BYPASS

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Abstract

As newer anesthesia ventilators are developed their capabilities are becoming more similar to intensive care unit (ICU) ventilators. However, in situations where there is severe decrease in lung compliance, an ICU ventilator may be superior in its ability to regulate inspiratory flow improving both ventilation and oxygenation. We present a case where an ICU ventilator was brought to the operating room and used in the treatment of ARDS post-cardiopulmonary bypass and ultimately allowed us to avoid extracorporeal membrane oxygenation (ECMO) therapy.

Case report

A 68-year-old man with developmental delay, chronic obstructive pulmonary disease, coronary artery disease and mitral, aortic and tricuspid insufficiency presented for a 3-vessel coronary artery bypass grafting, tricuspid annuloplasty, aortic valve replacement and mitral valve repair. Pre-operative echocardiography demonstrated dilated heart chambers with mild biventricular systolic dysfunction (left ventricular ejection fraction 50%), severe aortic insufficiency and severe mitral insufficiency. A pre-anesthetic-induction radial arterial line was placed and general anesthesia was induced using midazolam, fentanyl, etomidate and vecuronium. The patient was easily intubated, placed on the ventilator (Dexta Omheda ADU) with peak airway pressure of 14 mm Hg. The initial arterial blood gas showed pH 7.35, PaCO₂ 49, PaO₂ 482 on FiO₂ of 100%. An 9 Fr introducer sheath and pulmonary artery catheter were placed. Aminocaproic acid was used as an anti-fibrinolytic agent. Bypass was initiated uneventfully and lasted for approximately 4 hours. Epinephrine and norepinephrine was started prior to separation from cardio-pulmonary bypass (CPB). As ventilation was re-initiated peak airway pressures exceeded 50 mm Hg and eventually became unreadable on assist control. Ventilation mode was changed to pressure control with settings of inspiratory pressure set at 40 mm Hg. However we were only able to deliver tidal volumes of 140 ml. The arterial blood gas showed pH 7.16, PaCO₂ 62, PaO₂ 36 on FiO₂ 100%. Vasopressin and methylene blue were added to support mean arterial pressure and inhaled Nitric oxide was started due to impending right ventricular failure. An intra-aortic balloon pump was also initiated for

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severe right-heart failure. Despite these therapies, the patient remained difficult to ventilate and oxygenate. While the surgical staff considered extracorporeal membrane oxygenation (ECMO) as an intervention, an intensive care unit ventilator, a Nellcor Puritan Bennett 840, was brought into the OR and instituted using pressure control setting and high peep. The patient's pulmonary status improved gradually with the arterial blood gas improving to pH 7.36, PaCO₂ 43, PaO₂ 126 (FiO₂ 100%) and hemodynamics stabilized. The patient received a tracheostomy on post-op day 7 and after a prolonged hospital course, he was transferred to a rehabilitation facility.

Discussion

After an extensive literature review, we believe that this is the first case report of using an ICU ventilator in the operating room (OR) to improve gas exchange in a patient immediately post CPB to avoid ECMO. ARDS, also known as "pump" lungs when it occurs post-CPB is a lung injury that is associated with significant arterial hypoxemia and diffuse infiltrates radiologically, in the absence of elevated left atrial pressures. It is thought to be a result of extensive exposure of blood to foreign materials in the bypass circuit, resulting in the activation of complement and release of inflammatory mediators¹⁻³. Treatment of ARDS includes aggressive ventilation strategies to limit barotrauma and improve oxygenation. In severe ARDS however, ECMO therapy can be used to improve oxygenation and reduce ventilator associated

lung injury^{2,4,5}. In our case, the patient had a significant A-a gradient and hypercarbia despite aggressive ventilatory management on the traditional anesthesia ventilator and ECMO was being considered as the next therapy.

It is well documented that older anesthesia ventilators are inferior to ICU ventilators in terms of their ability to preserve tidal volume delivery with decreased compliance in test lung models when in pressure control mode⁵. Tung et al demonstrated that at high respiratory rates, a Puritan Bennett 7200, ICU ventilator was able to maintain tidal volumes with test model of a lung with low compliance with a pressure control setting compared to the Datex-Ohmeda Asteva 5 anesthesia ventilator. Anesthesia ventilators necessarily have greater compliance as gases are recirculated requiring a larger circuit volume. ICU ventilators have less compliance in their system as gases are delivered directly from the wall source to patient. Thus, ICU ventilators may be more efficient at delivering tidal volumes in patients with poor pulmonary compliance, requiring high pressure control settings and relatively high respiratory rates. The Dexta-Ohmeda ADU ventilator is a modern bellows system ventilator used at our institution. Despite advances in anesthesia machine ventilators, we found in this case report that the ICU ventilator (Nellcor Puritan Bennett 840) was superior to the anesthesia ventilator in its ability to manage severe ARDS and instrumental in improving oxygenation and ventilation in our patient.

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