ECMO for Acute Respiratory Distress Syndrome After Thoracoabdominal Aortic Aneurysm Repair

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Acute respiratory distress syndrome (ARDS) after thoracoabdominal aortic aneurysm (TAAA) repair poses a formidable challenge. Despite conventional maneuvers in the operating room, perioperative ARDS may require extracorporeal membrane oxygenation (ECMO). We present three cases of successful ECMO for ARDS after TAAA repair and discuss management of anticoagulation and cerebrospinal fluid drains. Our experience suggests that ECMO is reasonable in selected patients after TAAA repair.


Thoracoabdominal aortic aneurysm (TAAA) repair poses a pronounced risk of respiratory complications [1], including acute respiratory distress syndrome (ARDS). Extracorporeal membrane oxygenation (ECMO) produces favorable outcomes in ARDS cases [2]. We describe three cases of rapidly instituted ECMO for ARDS after Crawford extent I or II TAAA repair.

We previously showed that cerebrospinal fluid (CSF) drainage reduces the relative risk of paraplegia/paraparesis after TAAA repair by 80% [3]; the current incidence at our center is 5% [1]. No publications discuss the use of ECMO in patients with a CSF drain in place after TAAA repair. These three cases show that ECMO and anticoagulation are not absolutely contraindicated after TAAA repair. In each case, a CSF drain was placed before repair.

Case Reports

Patient 1

Three years after undergoing type I aortic dissection (AD) repair, a 53-year-old man underwent redo root replacement with a composite mechanical valve graft. ARDS that required temporary tracheostomy complicated the reoperation. Three months later, he presented to an outside institution with acute lower-extremity ischemia that necessitated endovascular revascularization.

Then, 2 days later, he was transferred to our institution in shock and underwent emergent Crawford extent II repair of a ruptured TAAA. Left heart bypass time was 274 minutes; he received 22 units of packed red blood cells (PRBCs) and prothrombin complex concentrate (PCC). Profound hypoxemia and ARDS with hemodynamic instability developed, so venoarterial (VA) ECMO was initiated with left axillary artery graft and femoral vein cannulation.

Twelve hours later, he underwent reoperation for abdominal compartment syndrome. Unfractionated heparin was started 40 hours into the ECMO run; activated partial thromboplastin time (aPTT) was maintained at 1.5 to 2.5 times normal. He transitioned from VA ECMO to venovenous (VV) ECMO 2 days later. He received VV ECMO for 2 more days and was weaned off after 84 hours of total ECMO. The abdominal incision was closed the day after ECMO decannulation. The CSF drain was removed on postoperative day 6 without complications. Redo tracheostomy and dialysis were needed. After a 128-day hospital course, he was discharged to a long-term acute care (LTAC) facility where he died 2 months later.

Patient 2

A 53-year-old man with Huntington chorea presented for elective repair of a symptomatic 5.8-cm TAAA. Two years earlier, he survived an acute DeBakey type I AD repair that required temporary tracheostomy. For the extent I TAAA repair total cardiopulmonary bypass time was 195 minutes with 26 units of PRBCs.

During operation, hypoxemia and ARDS developed, requiring bifemoral VA ECMO. Heparin was started after 21 hours with decannulation after a 52-hour run. On postoperative day 4, the CSF drain was removed. He required redo tracheostomy and recovered renal function after temporary dialysis. There were no neurologic complications. After a 35-day hospital course, he was discharged to an LTAC. He was alive and well at home 3 years after operation.

Patient 3

A 43-year-old woman presented for aortic valve replacement and reoperative aortic arch operation. She underwent ascending and hemiarch repair for type I AD at age 30 years. She experienced aortic regurgitation and atherosclerotic degeneration of the dissected native aorta from the arch to the abdominal aorta. She underwent thoracic endovascular aortic repair (TEVAR) with a 31-mm Conformable Gore Tag graft (W. L. Gore & Associates, Flagstaff, AZ) at another institution 3 months before presenting to our center. After TEVAR, she experienced ARDS and needed a temporary tracheostomy.

At our center, she underwent reoperative bioprosthetic aortic valve and total arch replacement as stage 1 of an repair of a ruptured TAAA. Left heart bypass time was 274 minutes; he received 22 units of packed red blood cells (PRBCs) and prothrombin complex concentrate (PCC). Profound hypoxemia and ARDS with hemodynamic instability developed, so venoarterial (VA) ECMO was initiated with left axillary artery graft and femoral vein cannulation.

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At our center, she underwent reoperative bioprosthetic aortic valve and total arch replacement as stage 1 of an
elephant trunk repair. She required high-flow oxygen after extubation. Because the TEVAR was incomplete, staged elective repair was planned for the 7-cm TAAA. However, on postoperative day 8 she underwent emergency extent II TAAA repair with TEVAR extraction for contained rupture. Left heart bypass lasted 270 minutes, and she received 9 units of PRBCs and PCC.

Sixteen hours into her course in the intensive care unit, VV ECMO was started with bifemoral cannulation for ARDS. Argatroban was started 32 hours after ECMO initiation because of heparin-induced thrombocytopenia for the remainder of the 124-hour ECMO run. Seven days after operation, she underwent decannulation. The next day, the CSF drain was removed without complications. She required redo tracheostomy and temporary dialysis. She was discharged to LTAC 19 days after TAAA repair and was alive and well at home 6 months after operation.

Comment

These patients had complex aortic surgical histories and each had previous tracheostomy, perhaps suggesting a vulnerability to ARDS. Each required massive transfusions that resulted in transfusion-related acute lung injury [4] and ARDS. ECMO was successfully used as a rescue intervention. We specifically address two important concerns: ECMO-related anticoagulation and CSF drain management.

ECMO was initiated after conventional ARDS management (ie, lung-protective ventilation, inhaled prostacyclin, and increased positive end-expiratory pressure [PEEP]) failed to improve oxygenation. One patient required VV ECMO and 2 required VA ECMO to better maintain adequate blood pressure after TAAA repair. After ECMO for ARDS is initiated, lung rest with lung-protective ventilation at 4 to 6 mL/kg of predicted body weight, maintaining peak inspiratory pressures of 20 to 25 cm H₂O, minimizing high fraction of inspired oxygen, and maintaining PEEP at approximately 10 mm Hg is practiced [5].

The incidence of ARDS after TAAA repair is approximately 4%, so ECMO is rarely considered. These three cases occurred over a 5-year period when approximately 500 TAAA repair cases were performed. Although ECMO for ARDS after TAAA repair has not been reported, early hypoxemia (within 24 hours after cardiac operation) is associated with 46% in-hospital mortality [6]. Hypoxemia adversely affects oxygen delivery to the brain, spinal cord, and other vital organs.

In our practice, senior anesthesiologists expeditiously place a CSF drain before operation—even in emergencies, if possible. To maintain CSF pressure between 10 and 15 mm Hg, thereby reducing spinal cord deficit risk, CSF was passively drained during ECMO runs and monitored for signs of bleeding [7]. Patients were decannulated from ECMO, the aPTT was normalized, and CSF drains were removed in 1 to 2 days. We observed no neurologic complications.

Anticoagulation for ECMO is highly individualized, balancing the risk of surgical bleeding against circuit thrombosis. As with postcardiotomy ECMO, we waited 24 to 36 hours (21, 32, and 40 hours, respectively) before initiating anticoagulation, with a goal aPTT of 1.5 to 2.5 times normal value. These cases suggest that ECMO and anticoagulation are not contraindicated after TAAA repair. Although ARDS after TAAA repair is rare, salvage ECMO can be considered for cardiopulmonary support.

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