

Extracorporeal Membrane Oxygenation as a Bridge through Chemotherapy in B-Cell Lymphoma

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Abstract: A 41-year-old female presented with a large anterior mediastinal mass adjacent to the heart. Biopsy demonstrated lymphoma. Upon administration of chemotherapy, she developed cardiogenic shock requiring a 5-day course of extracorporeal membrane oxygenation (ECMO) as a bridge through her treat-

ment. After one cycle of chemotherapy, ECMO was discontinued and the patient completed her course of chemotherapy and recovered to hospital discharge. **Keywords:** ECMO, circulatory assistance, temporary, mediastinal tumor, chemotherapy. *JECT. 2015;47:52–54*

Large anterior mediastinal tumors are recognized causes of extrinsic airway and vascular obstruction. Sudden respiratory and hemodynamic collapse is not uncommon, especially at the time of anesthesia induction. The use of extracorporeal membrane oxygenation (ECMO) has been described in such emergent settings to restore hemodynamic stability (1–5). ECMO has also been used to support patients with tumor lysis syndrome through chemotherapy (6). We describe the early institution of ECMO in a patient with cardiogenic shock during chemotherapy for an anterior mediastinal mass as a bridge through treatment of her underlying lymphoma.

DESCRIPTION

A 41-year-old woman with a history of Crohn's disease, on infliximab and methotrexate immunosuppression treatment, presented to an outside institution with symptoms of abdominal bloating, weakness, and dyspnea. She was afebrile, normotensive, tachycardic, and mildly hypoxic.

Laboratory testing revealed acute renal failure (creatinine 2.0 mg/dL—baseline 1 mg/dL). Transthoracic echocardiogram demonstrated a large mediastinal mass and a small pericardial effusion with no tamponade. Pericardial window was performed with return of a small amount of fluid. Pathology demonstrated diffuse large B-cell lymphoma. Follow-up computed tomography of the chest demonstrated a 13.3 cm anterior mediastinal mass involving the pericardium and great vessels. She was transferred to our institution for further care.

On presentation to our institution, the patient was in mild respiratory distress. She was normotensive but tachycardic at 120–130 beats per minute, with diffuse pulmonary crackles, abdominal distension, prominent jugular venous distention, and pedal edema. Transthoracic echocardiogram demonstrated an ejection fraction of 75–80% and a 2.4 cm thick mass compressing the right ventricular outflow tract, with a small and underfilled left ventricle. Positron emission tomography revealed a 14 cm anterior mediastinal mass encasing the superior vena cava, anterior pericardium, and heart with a standard uptake value of 13.3 U as well as bilateral kidney involvement.

On hospital day two, lymphoma-specific chemotherapy was initiated with dexamethasone, etoposide, adriamycin, and vincristine. Uric acid level was 10 mg/dL, potassium 5.0 mmol/L, and phosphate 5.1 mmol/L prior to this. Allopurinol and rasburicase were started for tumor lysis syndrome prophylaxis. Shortly after initiation of chemotherapy,

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new ST elevations in leads V2-V4, 1, and aVL and ST depressions in leads 2, 3, and aVF were noted. Transthoracic echocardiogram at this time demonstrated a reduction in ejection fraction to 35% with severe right and left ventricular hypokinesis. Arterial blood gas demonstrated severe metabolic acidosis with pH 7.18, pCO₂ 38 mmHg, pO₂ 81 mmHg, HCO₃ 14.2 mmol/L, and a base deficit of 14.2 mmol/L. Lactate was 6 mmol/L. The patient was taken for emergent cardiac catheterization, which demonstrated normal coronary anatomy with a left ventricular end diastolic pressure of 30 mmHg. The patient became cyanotic during the procedure and was intubated. An intraaortic balloon pump was placed. On arrival to the coronary care unit, the patient developed hypotension with a systolic blood pressure of 70/50 mmHg and oliguria. Levophed 5 µg/min and continuous venovenous hemodialysis were initiated and chemotherapy was continued. Cardiogenic shock persisted with evidence of hypotension, organ hypoperfusion, acidosis, anuria, anasarca, and development of cool and pale extremities. Repeat uric acid level was 3.3 mg/dL, potassium 5.4 mmol/L, and phosphate 8.8 mmol/L.

In discussion with oncology, the patient's prognosis was estimated to be good given appropriate therapy. However, hemodynamic compromise precluded continued administration of chemotherapy and it was therefore decided to initiate venoarterial ECMO to provide bridging hemodynamic support while chemotherapy was given time to take effect. The patient was taken to the operating room

and administered 10,000 U of intravenous heparin. The right femoral artery intraaortic balloon pump was percutaneously exchanged for a 15-French arterial cannula (Medtronic Bio-Medicus no. 96570-015; Medtronic, Inc., Minneapolis, MN). A 5-French sheath was placed antegrade for ipsilateral limb perfusion (Terumo Pinnacle sheath no. RSS502; Terumo Medical Corp., Elkton, MD). A 21-French venous cannula was placed percutaneously via the left femoral vein into the superior vena cava under transesophageal echocardiographic guidance (Medtronic Bio-Medicus no. 96880-021, Medtronic, Inc.). ECMO support was initiated at 2–2.5 L/min at approximately 3000 rotations per minute (rpm) providing a cardiac index of 1.25–1.5 L/min/m² in addition to that generated by native cardiac ejection. The ECMO circuit included a Quadrox oxygenator (Maquet Corp., Wayne, NJ), CentriMag pump (Thoratec Corp., Pleasanton, CA), and Terumo tubing with Xcoating surface coating (Terumo Medical Corp.). Hypotension and acidosis resolved with discontinuation of vasopressor support.

Over the next 5 days ECMO was continued with flows of 2.5 L/min at 2500–3000 rpm. Ventilator settings were set to optimize oxygenation and ventilation as cardiac ejection continued (rate 6 breaths/min, pressure support 5 mmHg, positive end expiratory pressure 10 mmHg, tidal volume 400 mL, fraction of inspired oxygen 40%). Continuous venovenous hemodialysis and chemotherapy were continued. Partial thromboplastin times were kept at 60–80 seconds

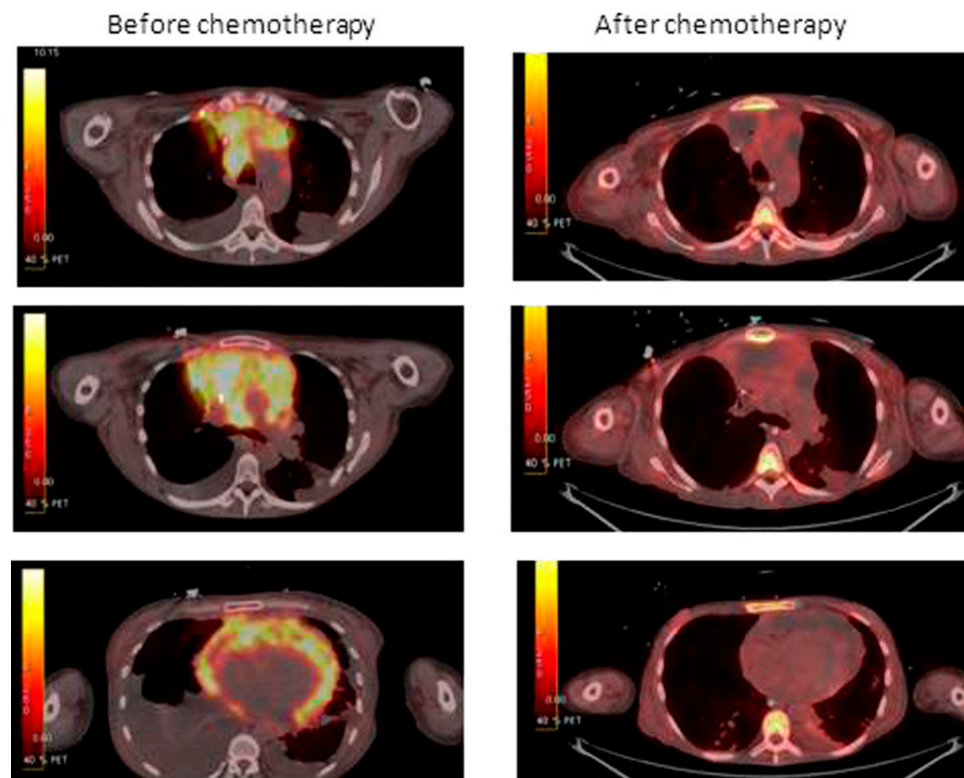


Figure 1. Positron emission tomography/computed tomography scanning before and after chemotherapy demonstrate a 1.5 cm reduction in size and a decrease in standardized uptake value from 13.3 to 2.4 U.

with a continuous heparin infusion. After completion of a 5-day course of chemotherapy, ECMO was discontinued and the patient decannulated at the bedside. Hemostasis was achieved with manual pressure. Hemodynamics were stable on explantation. Transthoracic echocardiogram revealed improvement in ventricular function.

Over the next several weeks, renal function returned with cessation of hemodialysis. Repeat positron emission tomography demonstrated a decrease in the size and metabolic activity of the mediastinal mass (Figure 1). The patient completed six cycles of chemotherapy without further cardiac compromise. The patient developed intermittent episodes of small bowel obstruction and pneumonia requiring tracheostomy and prolonged recovery. She was eventually decannulated, with complete restoration of cardiopulmonary and renal function. She was discharged to a rehabilitation facility on hospital day 144. She eventually developed cerebral metastatic disease and succumbed to related complications 8 months postoperatively.

COMMENT

The indications for cardiac and pulmonary support via ECMO have been expanding at a rapid pace. Anterior mediastinal masses frequently require biopsy or resection, chemotherapy, and radiation as part of current diagnostic and therapeutic algorithms (7). Induction of anesthesia in the setting of very large anterior mediastinal masses may result in acute cardiopulmonary decompensation requiring emergency measures. Proposed etiologies include airway compression exacerbated by the loss of spontaneous respiratory effort and accentuated compression in the supine position (1,8). Severe V-Q mismatch has also been described as a result of simultaneous left bronchial and right pulmonary artery compression (2,3), as has more classic cardiac tamponade (4,5). ECMO has been used in such catastrophic settings to support patients through their workup and chemotherapy with variable outcomes (1–5,8). It has also been used to support patients through chemotherapy in the setting of tumor lysis syndrome (6).

In the current report, we describe progressive cardiogenic shock likely secondary to either the acute effects of chemotherapy on a tumor compressing and/or infiltrating the myocardium, or tumor lysis syndrome, or a combination of these. It is possible that preexisting spontaneous tumor lysis syndrome was exacerbated by chemotherapy administration. This patient would have likely succumbed

to cardiac failure and subsequent multiorgan system failure in the absence of intervention. Lymphoma is known to be chemotherapy responsive. Our patient was rapidly decompensating at the time of chemotherapy initiation. ECMO was thus instituted urgently to restore hemodynamic stability, to improve end-organ function, and to bridge the patient during untoward consequences of additional chemotherapy administration until the tumor burden could be reduced adequately. After one cycle of chemotherapy, ECMO was discontinued and the patient went on to finish a full course of chemotherapy without further cardiac events.

In this patient, impending cardiac collapse was heralded by electrocardiographic changes, a sudden decrease in ejection fraction associated with an elevation in filling pressures, and metabolic acidosis with end-organ malperfusion. ECMO allowed for prompt recovery of hemodynamics with maintenance of end-organ function. This was likely due to its institution prior to complete hemodynamic collapse. Significant morbidity has been associated with the prolonged use of ECMO, including thrombotic and hemorrhagic complications. Timely institution prior to severe multiorgan failure allows for rapid weaning such that the patient can derive benefit from mechanical support while minimizing complications.

REFERENCES

1. Chao VTT, Lim DWT, Tao M, Thirugnanam A, Koong HN, Lim CH. Tracheobronchial obstruction as a result of a mediastinal mass. *Asian Cardiovasc Thorac Ann*. 2006;14:17–8.
2. Huang YL, Yang MC, Huang CH, et al. Rescue of cardiopulmonary collapse in anterior mediastinal tumor. *Pediatr Emerg Care*. 2010;26:296–8.
3. Takeda S, Miyoshi S, Omori K, Okumura M, Matsuda H. Surgical rescue for life-threatening hypoxemia caused by a mediastinal tumor. *Ann Thorac Surg*. 1999;68:2324–6.
4. Frey TKE, Chopra A, Lin RJ, et al. A child with anterior mediastinal mass supported with veno-arterial extracorporeal membrane oxygenation. *Pediatr Crit Care Med*. 2006;7:479–81.
5. Testolin L, Basso C, Pittarello D, Casarotto D, Valente M. Cardiogenic shock due to metastatic cardiac lymphoma: Still a diagnostic and therapeutic challenge. *Eur J Cardiothorac Surg*. 2001;19:365–8.
6. Prabhu AD, Mos K, Karl TR, Anderson B. Extracorporeal life support in the acute management of tumour lysis syndrome. *Interact Cardiovasc Thorac Surg*. 2012;15:568–9.
7. Duwe BV, Sterman DH, Musani AI. Tumors of the mediastinum. *Chest*. 2005;128:2893–909.
8. Aboud A, Marx G, Sayer H, Gummert JF. Successful treatment of an aggressive non-Hodgkin's lymphoma associated with acute respiratory insufficiency using extracorporeal membrane oxygenation. *Interact Cardiovasc Thorac Surg*. 2008;7:173–4.