A Patient with Abdominal Compartment Syndrome and Perforated Transverse Colon Successfully Managed with ECMO

Dear Editor,

Extracorporeal membrane oxygenation (ECMO) is considered to be contraindicated in patients with abdominal compartment syndrome (ACS).[1-3] Herein we report the case of a 24-year-old male with ACS complicated by septic shock successfully managed with ECMO.

Case Report

A 24-year-old male soldier was admitted to the intensive care unit (ICU) for exertional heat stroke. Endotracheal intubation was performed for respiratory and metabolic acidosis (pH, 7.008; $PaCO_2$, 66.6 torr; PaO_2, 131.9 torr; HCO_3-, 19.7 mmol/L). The patient recovered consciousness, bowel sounds were present, and nasogastric (NG) feeding was begun 17 hours later. The patient's condition gradually improved; however, 48 hours after admission his fraction of inhaled oxygen decreased from 100% to 40%. He was treated with hydration and dopamine infusion, and his oxygen saturation improved.

At the 72 hours after admission, the patient developed a fever of 38.9°C, and his white blood cell count was 1.03×109/L. He became agitated, his abdomen was distended, and cold limbs and marbled skin were noted. Laboratory testing revealed an amylase level of 204 U/L, lipase of 794.6 U/L, and glutamic-oxaloacetic transaminase (GOT) of 279 U/L. Chest X-ray showed bilateral infiltration and arterial blood gas testing revealed a PaO_2 of 59.9 torr on ventilator support with 100% oxygen. Abdominal sonography revealed an ileus and bowel dilatation which prevented an adequate study. Transthoracic echocardiography showed borderline of left ventricular (LV) regional wall motion with adequate LV systolic function and preserved right ventricular free wall motion and systolic function. Abdominal computed tomography (CT) showed scattered fluid and free air accumulation over the bilateral subphrenic regions and other peritoneal potential spaces. Collapse of the bilateral lower lungs, positive round-belly sign, bowel wall thickening with enhancement, and collapse of the inferior vena cava (IVC) were also noted (Fig. 1). The impression was high intra-abdominal pressure.

The patient became hypotensive (blood pressure 67/49 mm Hg) on the 4th hospital day. His heart rate was 142 beats/minute, SaO_2 was 66.1%, and PaO_2 was 32.1 torr. Shock was not controlled by hydration and a dopamine infusion (20 μg/kg/min). ECMO (Terumo Capiox SP101; Terumo Co., Japan) was begun in vein-to-vein mode. Venous blood was drained out from the inferior vena cava through right femoral vein cannulation and oxygenated blood was returned into right atrium through right internal jugular vein cannulation. After beginning ECMO, his oxygen saturation improved to 97% and blood pressure increased to 131/62 mm Hg with inotropic support.

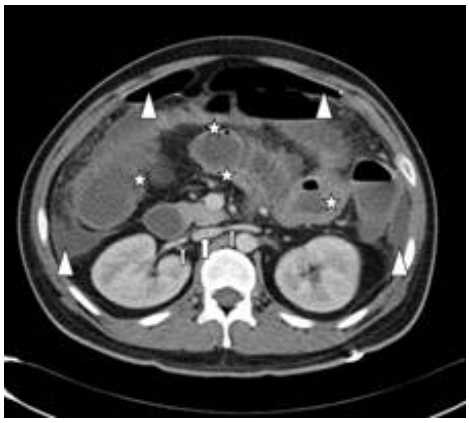

Fig. 1. Enhanced axial abdominal CT scan demonstrated (1) scattered fluid and free air accumulation over peritoneal potential spaces (arrowhead); (2) positive round-belly sign; (3) bowel wall thickening with enhancement (star); and (4) collapse of the IVC (big arrow) and renal veins (small arrows).

After 36 hours receiving ECMO, his vital signs stabilised and an exploratory laparotomy was performed. Perforation of the transverse colon near to spleen flexure was found. Hartmann's procedure was performed and drainage devices were set up. The abdominal wall was left open and covered with saline bag patch. ECMO was weaned and discontinued on the 8th hospital day (Table 1). Debridement was performed twice in the following days. The patient was discharged on the 35th hospital day. The colostomy was closed and reconstruction surgery was performed 6 months later without complication.

Table 1. Extracorporeal membrane oxygenation (ECMO) data

	Pump speed (r/min)	Blood flow (L/min)	SvO_2 (%)
1st day	1527	1.8	78
2nd day	1527	2.0	85
3rd day	1403	1.5	74
Post-laparotomy	1456	2.2	82
4th day	1193	1.8	77
5th day	1193	1.8	73

Comment

ECMO has become standard therapy in the treatment of severe adult respiratory syndrome (ARDS) when patients do not respond to conventional mechanical ventilator strategies. A series of case reports of ARDS combined with ACS suggest that ACS will compromise ECMO support, and vice versa. Insufficiency of venous drainage and overloading of the priming solution are the main problems described.[1-3] During venovenous (VV) ECMO, femoro-atrial (femoral drainage and atrial reinfusion) bypass seems to provide higher maximal extracorporeal flow, higher pulmonary arterial mixed venous oxygen saturation, and require comparatively less flow to maintain an equivalent mixed venous oxygen saturation than conventional VV atrio-femoral (atrial drainage and femoral reinfusion) ECMO support.[4]

Intra-abdominal hypertension (IAH) decreases pulmonary and respiratory system static compliances and increases airway resistance, alveolar-arterial oxygen gradient, and respiratory dead space. The presence of concomitant acute lung injury (ALI) exacerbates these findings. Positive end-expiratory pressure (PEEP) identical to abdominal pressure can moderately improved oxygenation and respiratory mechanics; however, an important decline in stroke index and right ventricle ejection fraction can be observed. In animal models, both PEEP and ACS can lead to cardiopulmonary deterioration though they act in different roles for ARDS.[5-7] A pilot study indicated that inadequate intra-abdominal pressure would result in detrimental respiratory and hemodynamic effects.[5]

Imbalance of perfusion to intra-abdominal organs is another pathophysiologic issue of ACS. Renal hypertension and collapse of the IVC reduce the renal perfusion and venous return to heart. ECMO with reverse VV (femoro-atrial) mode not only alters recirculation and extracorporeal flow, but also affords negative drainage pressure to the IVC and augments the difference between arterial perfusion pressure and venous pressure (Fig. 2).

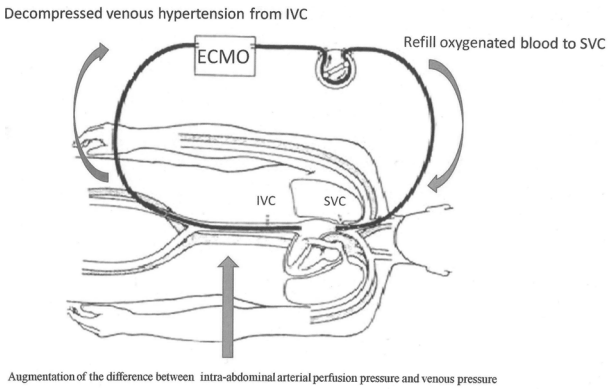

Fig. 2. Hemodynamic benefits of reverse VV mode ECMO in ACS.

Our case illustrates the benefit of reverse VV ECMO prior to decompressive laparotomy. It rescued the very ill patient so that damage control surgery could be performed with his cardiopulmonary condition stable.

In conclusion, reverse VV mode ECMO affords oxygenation of venous blood in ARDS and avoids IVC venous hypertension in ACS. It seems to correct the difficulty noted in previous case reports. Of course, decompressive laparotomy should be done in time and the underlined disease should be treated properly.

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