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Case Report

Veno-venous extracorporeal membrane oxygenation application for patient with acute lung injury due to rhabdomyolysis; a case report

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ABSTRACT

A 47-year-old male patient, who underwent open reduction and internal fixation with plate for a Gustilo-Anderson type II open proximal tibiofibular fracture of the right lower leg, experienced rhabdomyolysis. Rapid progression of acute respiratory distress syndrome and acute renal failure occurred due to rhabdomyolysis. After veno-venous extracorporeal membrane oxygenation, he exhibited a relatively smooth clinical recovery. Our case report suggests that circulating cytotoxic substances from rhabdomyolysis resulted in concomitant acute respiratory distress syndrome and acute renal failure. This case was successfully treated after applying extracorporeal membrane oxygenation.

Introduction

Concentration of plasma proteins is altered after trauma [1]. The level of serum albumin decreases, whereas the levels of serum globulin, c-reactive protein, creatine kinase, and myoglobulin increase [1]. Some of these substances might have cytotoxic effects. Circulating cytotoxic substances could damage the lungs, kidneys, or other important organs. Here, we present a successfully treated case with rapid progression of acute respiratory distress syndrome and acute renal failure occurred due to rhabdomyolysis. In this case circulating cytotoxic substances resulted in acute lung injury and acute renal failure. Injury to the popliteal artery may have been overlooked in the initial assessment as pulses were palpated in the dorsalis pedis and posterior tibial arteries, but not in the popliteal artery. Suspicion of popliteal artery occlusion or aggressive angiography would have prevented rhabdomyolysis at the time of orthopedic surgery.

Case report

A 47-year-old man was brought to the emergency room after a motorcycle accident. The primary survey revealed mild cerebral contusion and Gustilo-Anderson type II open proximal tibiofibular fracture of the right lower leg.

Emergency room examination identified a pulse in both the dorsalis pedis artery and posterior tibial artery. The next day, the patient underwent surgery for open reduction and internal fixation with plate. At 6 h postoperatively, the patient complained of severe

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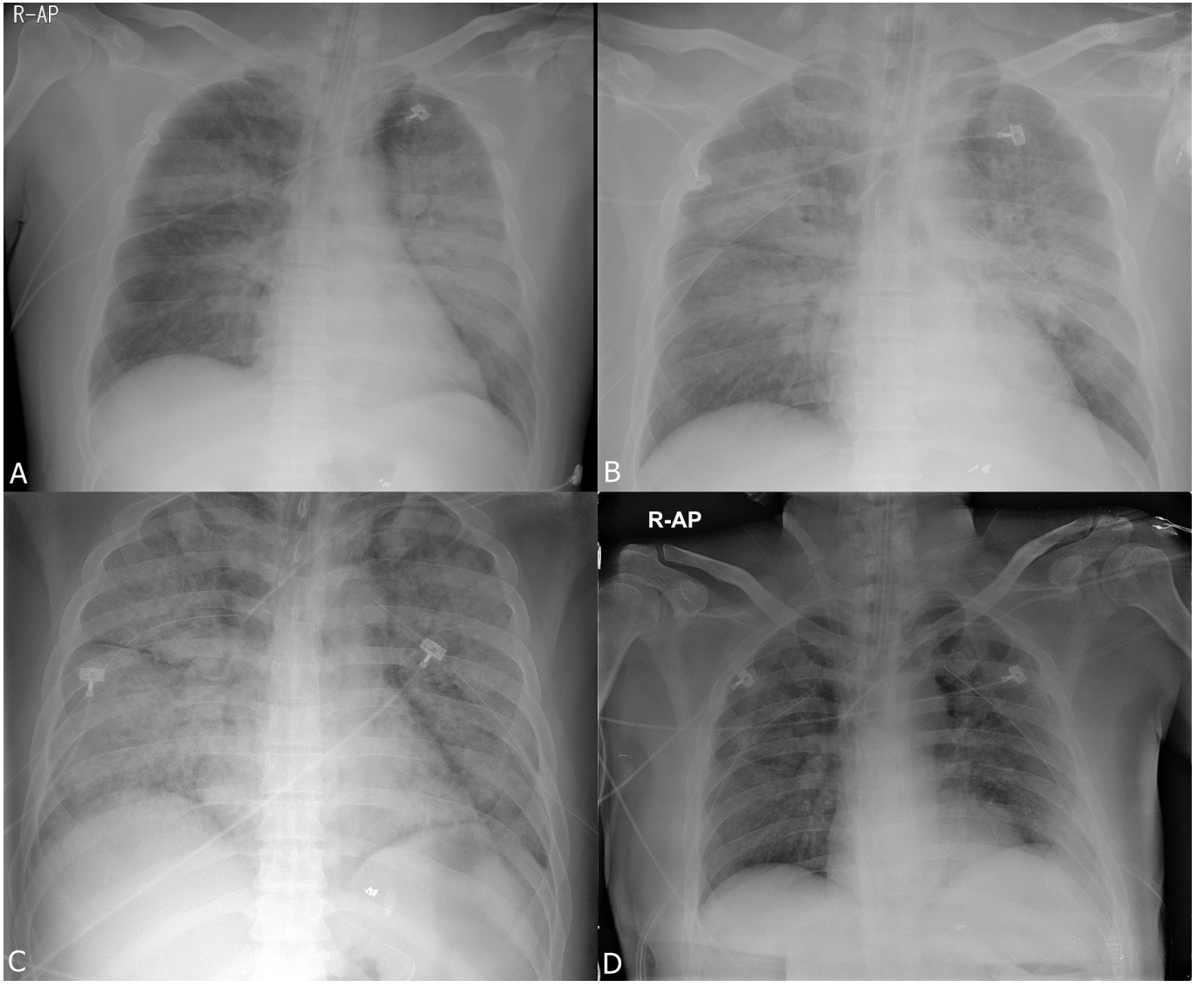

Fig. 1. (A) On the third postoperative day, the patient complained of worsening dyspnea even at rest, and a follow-up chest X-ray showed bilateral lung infiltration. (B) On the fourth postoperative day, his chest X-ray showed progressive lung infiltration and both pleural effusions. (C) On the seventh postoperative day, his chest X-ray showed progressive lung infiltration. (D) The lung infiltration on the chest X-ray rapidly resolved after six days on ECMO support.

Table 1

	POD 0	POD 1/stent insertion	POD 2/intubation, CRRT	POD 4	POD 6	POD 8/ amputation	POD 10 / ECMO	POD 12	POD 16/ weaning	POD 20/ tracheostomy	POD 25/CRRT stop
cRP (mg/dL)	0.38	16.45	14.75	31.39	26.27	23.28	21.54	16.42	11.92	6.34	13.57
CK (IU/L)	373	Over 7800	Over 7800	3675	1138	404	951	484	87	81	86
Urine-protein	–	+	+++	+++	+++	+++	NA	NA	NA	NA	–
Serum creatine (mg/ dL)	0.82	2.63	4.00	3.45	3.54	3.44	3.23	3.00	2.33	1.63	1.88
GFR	107.04	27.89	17.19	20.39	19.79	20.46	22.00	23.96	32.07	48.44	41.09
PaO_2 (mmHg)	179	194	66	88	63	62	31	137	127	185	147
FiO2				0.5	0.5	0.5	1.0	0.4	0.4	0.4	0.4

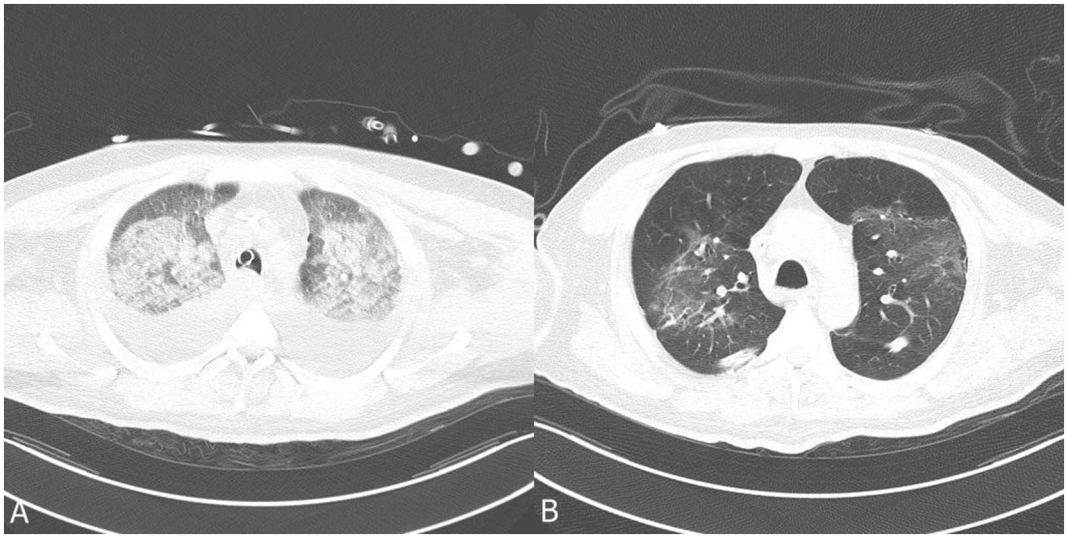

Fig. 2. (A) On the fourth postoperative day, the patient's CT scan showed progressive lung infiltration and both pleural effusions. (B) There was a sequela of lung injury in the CT taken one month later.

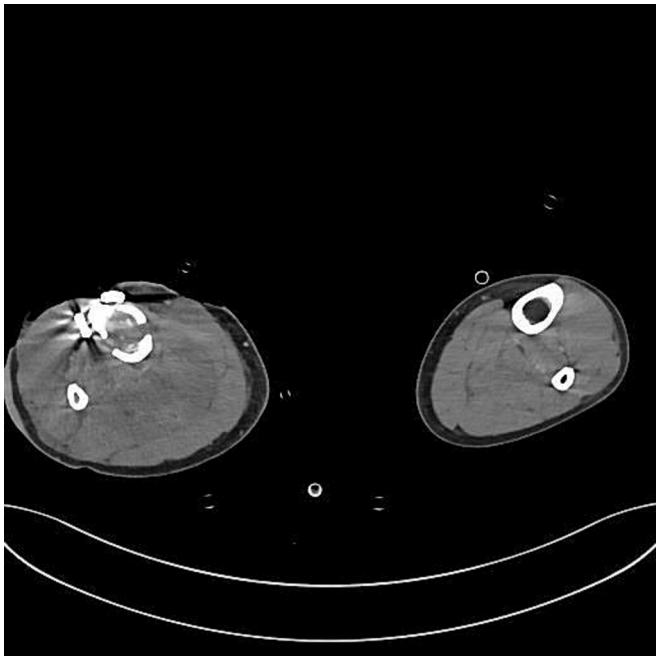

Fig. 3. Circulation in the lower leg was not sufficient and abnormal fluid collection was seen at the operative wound.

lower leg pain and decreased right foot sensation and paralysis. There was a notable reduction in pulse in the dorsalis pedis and posterior tibial arteries. Upon diagnosis of compartment syndrome, fasciotomy was performed immediately. However, on the first postoperative day, the patient's pulse in the lower leg had not recovered. Vascular injury was suspected and angiography was performed which showed complete occlusion of the left popliteal artery at the fracture site. A stent was inserted at the occlusion lesion. On the third postoperative day, the patient complained of worsening dyspnea even at rest, and a follow-up chest X-ray showed bilateral lung infiltration (Fig. 1A). Arterial gas analysis under 5 L/min of oxygen inhalation showed that arterial oxygen pressure was 66.0 mmHg and oxygen saturation was 92.0 % (Table 1). Intubation and mechanical ventilator support were initiated. Simultaneously continuous renal replacement treatment (CRRT) was applied for poor urine output. The left ventricular ejection fraction on echocardiography was 46 %. On the fourth postoperative day, the patient's chest X-ray and CT scan showed progressive lung infiltration and both pleural effusions (Figs. 1B, 2A). Circulation in the lower leg was not sufficient and abnormal fluid collection was observed at the

operative wound (Fig. 3). On the fifth postoperative day, lower leg amputation was performed to eliminate circulating necrotic materials from the operative lower leg, considering the time to stent insertion after the onset of the patient's compartment syndrome. His chest X-ray improved slightly postamputation, but chest X-rays showed progressive lung infiltration on the seventh postoperative day (Fig. 1C). Arterial gas analysis under FiO_2 100 % showed that arterial oxygen pressure was 31.0 mmHg and oxygen saturation was 48.0 % (Table 1). For sustained hypoxemia, the patient received veno-venous extracorporeal membrane oxygenation (ECMO) via the femoral and internal jugular veins. Bronchoscopy indicated that bronchial secretion was minimally sanguineous, and there were no abnormal findings suggesting the presence of bronchitis or pneumonia.

The clinical course after ECMO support was quite smooth, and the lung infiltration on the chest X-ray rapidly resolved during six days on ECMO support (Fig. 1D). The ECMO was weaned over one week and the CRRT was weaned at 25 postoperative days. CT taken one month later showed a sequela of lung injury (Fig. 2B). The patient is undergoing rehabilitation for his lower leg amputation on the general ward.

Discussion

Trauma, ischemic insult, toxic materials, or infection lead to rhabdomyolysis [2,3]. Rapid breakdown of skeletal muscle fibers lead to toxic cellular contents entering into systemic circulation [2,3]. Creatine kinase and myoglobulin are released by damaged muscle cells into the systemic circulation. Myoglobulin has a nephrotoxic effect, which is responsible for renal damage [2]. Not only mechanical obstruction of tubules, but also vasoconstriction, hypovolemia, and direct renal toxic effect of myoglobulin are important factors for renal failure [2,3]. In our case, the metabolites were partially removed using CRRT, however this was not sufficiently effective (Table 1). After amputation of the lower leg, the metabolite levels decreased sharply (Table 1).

The possible causes of acute lung injury are free radicals, proteinase, and soluble agents including cytokines, arachidonic acid metabolites, and charged proteins [4]. These substructures disrupt the normal alveolar-capillary barrier [4]. Acute hypoxemic respiratory failure occurs, with bilateral pulmonary infiltrates that are not attributed to left atrial hypertension [5]. There was positive correlation between increases of extravascular lung water content, reflecting lung edema, and macroglobulin concentration in urine [6]. Damage to alveolar epithelium was seen in elevated bronchial alveolar lavage in patients with acute respiratory distress syndrome [6]. As a result, the mortality rate of acute lung injury is about 40 % [5]. In this case, creatine kinase and urine protein increased as the muscle was broken down. We tried to remove cytotoxic materials by CRRT, but this was not sufficiently effective and acute lung injury occurred (Table 1). Although we tried to remove newly generated cytotoxic materials by amputation of the necrotic lower leg, the circulating cytotoxic materials that could not be entirely removed through CRRT gradually caused lung damage. If the kinked popliteal artery was found earlier, the outcome would have been better. We believe that this patient may have been saved through ECMO support.

CRediT authorship contribution statement

Dongsub Noh: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Yong Han Cha:** Data curation.

Declaration of competing interest

The authors declare that they have no competing interests.

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