



# Veno-venous extracorporeal membrane oxygenation in a deeply hypoxemic infant with persistent air leakages: The first successful pediatric veno-venous extracorporeal membrane oxygenation case report in Turkey

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## Abstract

In severe respiratory failure, extracorporeal membrane oxygenation support is life-saving, but it has been started to be used in pediatric intensive care units in our country very recently. Here, we present a five-month old girl who developed acute respiratory distress and air leakages following removal of a foreign body obstructing the airway. Mechanical ventilation only increased the air leaks and - despite drainage-resulted in hypoxemia, acidosis and finally cardiopulmonary arrest. Initiation of veno-venous (VV) ECMO improved oxygenation as well as hemodynamics. The patient was weaned off extracorporeal membrane oxygenation support on the 7th day with improvement in the lung parenchyma and ceasing of the air leakages; she was discharged on the 27<sup>th</sup> day of her hospitalization without any neurological sequelae. As far as we know, this patient is the first pediatric patient who was discharged with success after application of venovenous-extracorporeal membrane oxygenation with a respiratory indication in a pediatric intensive care unit in our country. We think that similar patients who need extracorporeal membrane oxygenation can be cured with close collaboration of specialists of cardiovascular surgery and pediatric intensive care, dedicated nurses and perfusionist support when necessary. (Türk Ped Arş 2014; 49: 66-9)

**Key words:** Pediatric intensive care unit, extracorporeal membrane oxygenation, airway obstruction, pneumothorax, respiratory failure

## Introduction

Extracorporeal membrane oxygenation (ECMO) is a supportive therapy which is administered in severe respiratory and/or cardiac failure which does not respond to advanced medical treatment. During the procedure, the blood is ventilated with an artificial lung outside the body and given back to the patient. The system is called veno-venous (VV) ECMO when the oxygenated blood is given back to the circulation by way of main vein and veno-arterial (VA) ECMO when the oxygenated blood is given back to the circulation by way of main artery. VA is used for circulatory failure and VV or VA-ECMO is used for respiratory failure. Extracorporeal membrane oxygenation is a technique which is used widely in developed centers. Its efficiency has been shown in newborns and adults in randomized controlled studies (1, 2). The use of ECMO which is a life-saving application in experienced centers is in the beginning phase in our country.

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## Case

A previously healthy 5-month old female infant presented to our emergency department by ambulance under oxygen support. Her mother recognized that the infant became cyanotic and could not breathe, the plush toy which obstructed respiration was removed from her mouth and the infant was brought to the nearest primary health care center. At presentation, her consciousness was open and she was agitated, tachypneic and dyspneic. The patient who had hypoxemic respiratory failure and bilateral extensive white lung appearance on direct lung graphy was internalized in the pediatric intensive care unit. She was evaluated by pediatric surgery with the suspicion of a foreign body which might have remained behind. On thin-section lung tomography, findings compatible with lung hemorrhage and edema were observed and foreign body was eliminated. Fluid loading was applied in the patient who had mixed acidosis and nasal oxygen support was given with positive airway pressure method. Bilateral pneumothorax was found on lung graphy which was repeated because of hypoxemia which deepened in a few hours. Although regression was found in the appearance of pneumothorax after chest tubes were placed, the patient was intubated, since hypoxemia did not improve. Intervention with inotropic support and fluid boluses was performed in the infant who had decreased lung compliance, could not tolerate increased positive end-expiratory pressure and developed hypotension and bradycardia. The patient in whom ventilation and oxygenation could not be provided despite active drainage of air leakages and high positive end-expiratory pressure at the pressure control mode was considered to be a candidate for extracorporeal life support (Figure 1). Cardiovascular surgery and perfusion team was called after obtaining consent from the family. The patient in whom cardiac arrest developed during preparation was cannulated at the bedside by the surgical team (right internal jugular vein, OriGen-15F double lumen ECMO catheter) and veno-venous ECMO life support was started under resuscitation intervention. *Rotaflow* centrifugal blood pump, *Quadrox- ID* pediatric oxygenator, heat exchanger and heparinized tubing was used in the extracorporeal membrane oxygenation system. The blood flow was kept in the range of 700 and 900 cc/min. A marked increase in oxygen saturation (80-90%) and hemodynamical improvement was provided. Ventilatory support variables, blood gases and oxygenation indicators of the patient before ECMO and at the first hour and 24<sup>th</sup> hour after ECMO are shown in Table 1. Inotropic support with adrenaline under ECMO was gradually decreased and discontinued in 72 hours. Anticoagulation with heparin was provided during the period of ECMO. In the follow-up, activated coagulation time (ACT) was kept between 160 and 180 s and aPTT was kept between 60 and 80 s. Blood transfusions were performed as necessary such as to keep the hematocrit value above 40% and the platelet number above 100 000/mm<sup>3</sup>. Prophylactic antibiotic treatment with teicoplanine and ceftriaxone was given, since the patient was cannulated under resuscitation intervention. Sedoanalgesia and paralysis was applied with morphine, midazolam and rocuronium during the period of ECMO. Awakeness was



**Figure 1. Marked air leakages on lung graphy despite chest tubes before extracorporeal membrane oxygenation**

observed in the patient when paralysis was discontinued in 24 hours with clinical stabilization. Tissue oxygenation was monitored by NIRS (near infrared spectrometry method during the application and renal and brain tissue oxygen saturations of the patient remained between 60% and 80% which were within the normal limits. No problem developed except for bleeding from the cannula site which could be controlled by compression. The patient in whom air leakages improved and improvement in lung parenchyma was observed was removed from ECMO life support on the 7<sup>th</sup> day. She was extubated on the 4<sup>th</sup> day after decannulation and received supportive treatment subsequently because problems including stridor, vomiting and withdrawal syndrome. On the 27<sup>th</sup> day of internalization in the pediatric intensive care unit, she was discharged with normal systemic and neurological examination. No physical or neurological problem was found in the first, second and fourth week visits.

## Discussion

Extracorporeal membrane oxygenation is applied in patients with a high risk of mortality (80% and above) who have the potential of improvement (3). Since oxygenation and ventilation are provided by membrane lung in this method, lung damage related with ventilator will be reduced and time will be gained for recovery and application of potential therapies. The extracorporeal life support organization (ELSO) is a data bank for centers which apply ECMO and has been providing international documentation since 1989. According to the data of the extracorporeal life support organization, 65% of the patients who have been applied ECMO with respiratory indications can be separated from ECMO and 56% can be discharged from hospital (4). Veno-ve-

**Table 1. Variables belonging to the ventilator and the patient before and after extracorporeal membrane oxygenation**

Variable	Before ECMO*	ECMO 1 <sup>st</sup> hour	ECMO 24 <sup>th</sup> hour
Frequency/min	60	10	10
PIP (cmH <sub>2</sub> O)	30	23	23
PEEP (cmH <sub>2</sub> O)	10	8	8
FiO <sub>2</sub>	1.0	0.3	0,25
pH	6,75	6.99	7,30
pCO <sub>2</sub>	86	23	42
paO <sub>2</sub>	44	77	80
SpO <sub>2</sub>	50,4	88	95
Lactate mmol/L	11,7	16	2,7
PaO <sub>2</sub> /FiO <sub>2</sub>	44		
Oxygenation constant	46		

ECMO: extracorporeal membrane oxygenation; FiO<sub>2</sub>: fraction of inspired oxygen; PIP: peak inspiratory pressure; PEEP: positive end-expiratory pressure; PaCO<sub>2</sub>: partial arterial carbon dioxide pressure; PaO<sub>2</sub>: partial arterial oxygen pressure; SpO<sub>2</sub>: pulse oxygen saturation, oxygenation index: (MAP x FiO<sub>2</sub> x 100)/ PaO<sub>2</sub>, \*before cardiac arrest

nous ECMO method provides oxygenation and ventilation by artificial lung (oxygenator), but does not give direct hemodynamical support to the patient. Hemodynamical improvement can only be observed secondary to achievement of sufficient oxygenation and reduction of ventilator pressures. If cardiac support is required for the patient, VA-ECMO should be selected. Veno-arterial-ECMO can be used both in cardiac and respiratory failure. In our patient who developed lung edema and hemorrhage after airway obstruction was eliminated, pneumothorax developed with nasal positive airway pressure and a picture of white lung was observed despite drainage with chest tubes and application of interventional ventilation with intubation.

In our patient who primarily had hypoxemia and hypercarbia, VV-ECMO support was planned and the procedure was started. Although VA-ECMO support would be a more appropriate option since it would provide hemodynamic stabilization in our patient who developed cardiac arrest during the intervention, it would prolong the period to start the procedure because of requirement for both arterial and venous cannulation. Therefore, venous cannulation was performed rapidly as planned and ECMO support was started. Circulation problem was eliminated with achievement of oxygenation by veno-venous ECMO, improvement of acidosis and reduction of ventilator pressures. With this support mechanical ventilation problems were avoided and air leakages in the lung decreased and stopped. ECMO support applied when cardiac arrest develops is called E-CPR (cardiopulmonary resuscitation) and this support is given by VA method. When VA and VV-ECMO methods used in newborns and children were compared retrospectively, it was found that the requirement for

hemodynamic support was similar, if there was no underlying congenital heart disease, but neurological disorder was observed with a lower rate with VV-ECMO support (5).

The most commonly reported problem in ECMO support with respiratory indication is bleeding at the cannulation site with a rate of 16.8% (4). In our patient, this was the only problem observed and could be easily controlled with compression.

In our country, pediatric ECMO applications have started to be used in congenital heart centers for the aim of circulatory support following surgery and positive experiences have been obtained (6). Use of pediatric VV-ECMO with respiratory indication has come to the forefront with establishment of Pediatric Intensive Care subspecialty.

The patient presented here is the first pediatric patient who received VV-ECMO support in a pediatric intensive care unit and discharged without any problem in our country as far as we know. In tertiary centers like our university, ECMO applications are possible with close collaboration of cardiovascular surgery and pediatric intensive care divisions and success can be obtained with right indications and timing. Continuous perfusionist support is not required, since the use of new ECMO systems is easier. It has been shown that the success is proportional to annual ECMO number in institutions where ECMO is used (7) and application in reference centers might also be superior economically (2,8). Development of extracorporeal therapies should be supported in selected tertiary care centers in our country and experiences should be increased.

**Informed Consent:** Written informed consent was obtained from patients' parents who participated in this case.

**Peer-review:** Externally peer-reviewed.

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