Journal of Critical Care (2013) **28**, 669–674

ELSEVIER

Journal of Critical Care

Use of venovenous extracorporeal membrane oxygenation in central airway obstruction to facilitate interventions leading to definitive airway security ☆

Yoonki Hong MD [a], Kyung-Wook Jo MD [b], Jiwon Lyu MD [c], Jin Won Huh MD [b], Sang Bum Hong MD [b], Sung-Ho Jung MD [d], Jin Hyoung Kim MD [e], Chang Min Choi MD [b,*]

[a] *Department of Internal Medicine, Kangwon National University Hospital, Chuncheon, Korea*
[b] *Department of Pulmonary and Critical Care Medicine, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea*
[c] *Department of Pulmonary and Critical Care Medicine, Soonchunhyang University College of Medicine, Cheonan*
[d] *Department of Thoracic and Cardiovascular Surgery, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea*
[e] *Department of Radiology and Research Institute of Radiology, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea*

Keywords:
Venovenous extracorporeal membrane oxygenation (VV ECMO);
Central airway obstruction;
Rigid bronchoscopy;
Tracheal stent

Abstract

Purpose: Extracorporeal membrane oxygenation (ECMO) is useful for providing hypoxic patients with ventilatory support, but its usefulness in the management of patients with central airway obstruction has rarely been reported. Nineteen cases in one center where venovenous (VV) ECMO was used to support patients with severe central airway obstruction while they underwent lifesaving interventions are reported here.

Methods: In total, 113 cases of VV ECMO were performed in Asan Medical Center between January 2009 and June 2012. In 19 cases (18 patients), VV ECMO was used to support patients with severe airway obstruction.

Results: Of the 18 patients, 13 were male, and their median age was 62.5 (range, 16-82) years. The main reasons for using ECMO to provide airway security were malignant mass removal with a rigid bronchoscope (8 cases) and insertion of a tracheal stent (7 cases). The median ECMO time was 20.9 (range, 2.2-113.4) hours. In 1 case, a patient died of massive bleeding after a malignant mass was removed. Weaning off ECMO therapy occurred successfully in the remaining 18 cases.

Conclusions: Venovenous ECMO may be useful in patients with central airway obstruction because it provides short-term airway security while lifesaving procedures are being performed.

☆ Conflicts of interest and source of funding: We certify that there is no conflict of interest with any financial organization regarding the material.

* Corresponding author. Department of Pulmonary and Critical Care Medicine, Asan Medical Center, College of Medicine, University of Ulsan, Songpa-gu, Seoul 138-736, South Korea. Tel.: +82 2 3010 5902; fax: +82 2 3010 6968.
E-mail address: ccm@amc.seoul.kr (C.M. Choi).

0883-9441/$ – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jcrc.2013.05.020

1. Introduction

Extracorporeal membrane oxygenation (ECMO) has been used to manage cardiac and respiratory failure for more than 30 years. It has also emerged as a useful means of short-term support in hypoxic patients for nontraditional indications such as upper airway surgery [1,2], pulmonary embolism [3], and malignant airway obstruction [4]. However, there are a few reports of the use of ECMO to provide airway security in patients with an obstructed airway while their obstruction is being managed.

Obstruction of the central airways, the trachea and mainstem bronchi, can result from a variety of disease processes and is the cause of significant morbidity and mortality. The most common cause of central airway obstruction is direct extension from an adjacent tumor, most commonly bronchogenic carcinomas [5]. The incidence and prevalence of central airway obstruction are probably rising owing to the increasing number of patients who have complications of proximal endobronchial disease that develop during the progression and management of bronchogenic carcinoma [6].

When the airway becomes critically narrowed, the life of the patient is threatened because of impending suffocation. Prompt intervention can be lifesaving and provides immediate palliation for patients with symptomatic airway obstruction. It may also simplify other managements such as chemotherapy or radiation. In such patients, establishing airway patency and restoring ventilatory flow are essential components of treatment. To ensure adequate ventilation (CO_2 removal) and oxygenation in unstable patients with central airway obstruction, endotracheal intubation and rigid bronchoscopy are preferred [5]. However, in very severe cases, these procedures may be impossible and even dangerous, possibly leading to complete airway obstruction. Indeed, in such cases, all diagnostic and therapeutic modalities are risky. In managing patients with severe central airway obstruction, a thorough knowledge of the etiology, physiology, diagnostic, and treatment options is required along with a multidisciplinary team approach. Currently, the process of evaluation and management is specific to each medical center.

Venovenous (VV) ECMO can help to ensure adequate ventilatory function (CO_2 removal and oxygenation) when performing interventional procedures in patients with central airway obstruction. Our center has used VV ECMO since 2009 to ensure airway security in cases of severe airway obstruction. The present article describes the largest series of patients with central airway obstruction who underwent bridging VV ECMO for airway support during interventions for obstructed airway.

2. Methods

The data of 18 patients with central airway obstruction who were supported by VV ECMO were reviewed retrospectively. One patient was supported with VV ECMO twice. These cases were selected from the 113 cases of VV ECMO that were performed in Asan Medical Center, Seoul, Korea, between January 2009 and June 2012. Venovenous ECMO was indicated when the physicians judged on the basis of computed tomography or flexible bronchoscopic findings that the conventional intervention for obstructed airway was dangerous or impossible given the risk of complete obstruction.

In all cases, VV ECMO support was set up in the intensive care unit, established by the cardiovascular surgeons and maintained with the medical intensivists. Two types of centrifugal pumps were used for ECMO system: Capiox Emergency Bypass System (Terumo, Inc, Tokyo, Japan) and Centrifugal Rotaflow pump (Maquet Inc, Hirrlingen, Germany). Vascular cannulation was established with venous drainage from the femoral vein to the contralateral femoral vein, using 17F to 28F venous cannulae (RMI, Edwards Lifesciences LLC, Irvine, CA). Anticoagulation management was done by initial intravenous injection of heparin during vascular cannulation of ECMO, and in some cases, continuous infusion of nafamostat mesilate (a synthetic protease inhibitor with a short half-life) maintained the activated clotting time (ACT) at 130 to 150 seconds. The patients were weaned off the VV ECMO support gradually when the oxygen fraction of the oxygenator was less than 30% and after flexible bronchoscopy revealed airway patency.

In patients with central airway obstruction caused by a malignant mass, the mass was removed to restore airway patency. After inserting a rigid bronchoscope, the lesion was examined by a flexible bronchoscope. Depending on the type of lesions, laser, cryotherapy, and rigid forceps were used to remove or dilate the lesions. In some cases, expandable metallic stents were inserted under fluoroscopic guidance and flexible bronchoscopy by radiologists. For this, a guide wire was inserted across the stricture into the distal portion of the trachea or bronchus through the working channel of the bronchoscope. Bronchoscopic evaluation was performed immediately before and after stent placement.

The medical records and procedure notes of VV ECMO were reviewed to determine the demographic characteristics, the underlying disease, the interventional modalities used for airway obstruction, the outcomes of VV ECMO support, and the complications associated with VV ECMO. The data are presented as medians (range) for continuous variables and as percentages for discrete variables. These variables were analyzed by using simple descriptive statistics.

Our institutional review board approved the analyses of the clinical and ECMO data (Institutional Review Board of Asan Medical Center S2012-0055-0002).

3. Results

A case series of VV ECMO used as a bridge to support interventions for severe airway obstruction is summarized in Table 1.