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Cardiopulmonary Resuscitation with Extracorporeal Membrane Oxygenation for Cardiotomy Cardiogenic Shock: Case Report

Post Kardiotomi Kardiyojenik Şok Nedeniyle Ekstrakorporeal Membran Oksijenasyon ile Kardiopulmoner Resüsitasyon: Olgu Sunumu

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ABSTRACT

Extracorporeal membrane oxygenation is a life-saving method when it is used with appropriate indications in cases of combined failure where cardiovascular system failure, respiratory system failure or each two system has failed with different proportions. Extracorporeal membrane oxygenation was successfully used in 1972 in a group of patients with lung failure. Today, it is widely used in patients with postoperative resistant low-flow rates. Extracorporeal membrane oxygenation may be used in cases of post-cardiotomy, resistant cardiogenic shock, or with some limited indications, in cardiopulmonary resuscitation. Extracorporeal membrane oxygenation implantation is rare with indications of both conditions. In this case report, we aimed to present a 47-year-old female patient who underwent successful extracorporeal cardiopulmonary resuscitation rather than entering cardiopulmonary bypass for the third time after sudden cardiac arrest resistant to medical therapy.
Keywords: Extracorporeal membrane oxygenation; cardiopulmonary resuscitation; cardiopulmonary bypass.

ÖZ

Ekstrakorporeal membran oksijenasyonu, kardiyovasküler sistem yetmezliği, solunum sistemi yetmezliği veya her iki sistemin farklı oranlarda başarısız olduğu durumlarda uygun endikasyonlarla kullanıldığında hayat kurtarıcı bir yöntemdir. Ekstrakorporeal membran oksijenasyon, ilk olarak 1972 yılında bazı akciğer yetmezliği olan hastalarda başarılı şekilde kullanılmıştır. Günümüzde postoperatif dirençli düşük debi gelişen hastalarda yaygın olarak kullanılmaktadır. Ekstrakorporeal membran oksijenasyon uygulaması genelde postkardiotomi dirençli kardiyojenik şok olgularında ya da bazı sınırlı endikasyonlar ile kardiopulmoner resüsitasyonda kullanılabilir. Her iki durumun birlikte olduğu endikasyon ile ekstrakorporeal membran oksijenizasyon uygulaması nadirdir. Bu olgu sunumunda, medikal tedavisi sürerken ani kardiak arrest sonrası üçüncü defa kardiyopulmoner bypassa girmek yerine başarılı şekilde ekstrakorporeal kardiyopulmoner resüsitasyon uyguladığımız 47 yaşında kadın hastayı sunmayı amaçladık.
Anahtar kelimeler: Ekstrakorporeal membran oksijenasyon; kardiyopulmoner resüsitasyon; kardiyopulmoner bypass.

INTRODUCTION

Extracorporeal membrane oxygenation (ECMO) is a life-saving method when it is used with appropriate indications in cases of combined failure where cardiovascular system failure, respiratory system failure or each two system has failed with different proportions. ECMO was successfully used in 1972 in a group of patients with lung failure (1). Today, it is widely used in patients with postoperative resistant low-flow rates (2). Recently, ECMO has been used for limited indications in cardiopulmonary resuscitation (3). The indications of the use of ECMO as both postcardiotomy low-flow syndrome and ECMO cardiopulmonary resuscitation (e-CPR) are rare. In this report, we aimed to present a 47-year-old female patient who had low flow cardiac arrest after postcardiotomy, and had a sudden cardiac arrest for the third time while

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medical treatment was in progress, we performed successful e-CPR instead of going on cardiopulmonary bypass again.

CASE REPORT

A 47-year-old female patient was admitted to the cardiology clinic with chest pain. According to coronary angiography, elective coronary artery bypass graft surgery (CABG) operation was decided in cardiology and cardiovascular surgery council. Preoperative transthoracic echocardiography (TTE) revealed no pathology and the ejection fraction (EF) was 50%. The patient underwent elective CABGx5. The patient developed hypotension which was resistant to medical treatment. The patient was immediately cannulated and went on the cardiopulmonary bypass (CPB). All grafts were found to be patent. Ao-LAD bypass was performed on the beating heart as a vasospasm in the LIMA graft detected.

An intra-aortic balloon pump (IABP) was inserted through the left femoral artery. CPB with IABP and the medical treatment was started. The patient was decannulated. Hypotension followed by the cardiac arrest occurred during bleeding control. Internal cardiac massage was started immediately. Cardiac massage was continued 100 times per minute and mean arterial pressure was 80-90 mmHg (under invasive arterial monitoring). Instead of restarting the CPB, it was decided to administer ECMO. For this purpose, percutaneous right femoral artery-left femoral vein veno-arterial (VA) e-CPR procedure was performed. At the 10th minute of internal cardiac massage, non-pulsatile arterial pressure was achieved with ECMO support.

Distal perfusion in the femoral artery was achieved with percutaneous 9F introducer sheath. Then the heart started to beat in sinus rhythm. When the heart started, pulsatile arterial blood pressure was obtained at an average of 70 mmHg in ECMO support. Following the bleeding control, the patient was taken to the intensive care unit with ECMO and IABP support by closing only the skin (open sternum). Heparin infusion was started targeting an average activated coagulation time (ACT) of 160-180 seconds. The patient was conscious and there was no major neurological complication on postoperative day 1. The patient was stable with ECMO support. ECMO's rounds per minute (rpm) support could not be reduced at the end of the first 2 days postoperatively. As the patient tolerated, ECMO rpm was gradually reduced after the second postoperative day. The patient was separated from ECMO support on the postoperative 4th day after the hemodynamic parameters were stable on clinical follow-up and on TTE, EF was found to be 30%. Since ECMO cannulae were inserted percutaneously, decannulation was performed in the intensive care unit. Bleeding control was achieved with approximately 1 hour of compression. Following IABP and inotropic support ceased. The patient was taken to the normal ward. There were no complications related to ECMO's vascular application in the clinical follow-up. During the follow-up period, EF was 40% and the patient was discharged on the 25th postoperative day. The patient had no complaints at the postoperative 2nd month out-patient clinic control and the EF on TTE was 50% (the same as the preoperative EF value). Informed consent form was obtained.

DISCUSSION

Extracorporeal membrane oxygenator is an important vital support system used in refractory post-cardiotomy low flow syndrome. In postcardiotomy low flow syndrome, the first step in treatment is medical treatment. In cases resistant to medical treatment, the second stage is IABP. ECMO may be used with appropriate indications as the third stage in low-flow conditions that do not improve with medical treatment and IABP. ECMO is used to bridge the patient to complete recovery or to implantation of left ventricular assist device. In our case, ECMO was used as a bridge to complete recovery from low flow postcardiotomy syndrome. Normally, in postcardiotomy low flow syndromes, if the patient is decannulated and resistant to medical treatment (including IABP), they can be recannulated and put onto CPB. In recent years, the use of ECMO during CPR has been raised (e-CPR). It has been reported that e-CPRs have superior results compared to classical CPRs with correct indications (3). The most important indication of e-CPR is that cardiac arrest has a reversible cause and that the CPR is started in the first 10 minutes after cardiac arrest. In our case, it was decided to start an ECMO support (instead of entering CPB for the 3rd time) since we administered effective internal cardiac massage and made sure that there was a reversible cause of the cardiac arrest. In this regard, e-CPR was applied in our case. There is no specific definition of e-CPR. When the literature is reviewed, it is seen that e-CPR has been cited as a CPR performed by ECMO in patients with cardiac arrest within the hospital perimeters following certain rules. In this respect, we think that our case meets the e-CPR approach. Due to the effective internal cardiac massage under real-time arterial blood pressure monitoring, we took the e-CPR decision relatively easily. We think that the fast decision-making process and the fast organization are also effective. In the literature, we could not find any cases of VA ECMO implantation with both postcardiotomy low flow and e-CPR indications.

In general, we think that percutaneous VA ECMO may be implanted in patients who are suitable after post-cardiotomy cardiac arrest instead of going on CPB for several times. In elective cases, cannulation sites are generally determined by the choice of the surgeon and following the indications. In peripheral VA ECMO applications, femoral artery or subclavian artery may be preferred for arterial cannulation. Arterial cannulation can be achieved by direct cannulation or grafting. Although direct cannulation is an advantage in speed, it has a significant disadvantage in terms of distal extremity ischemia. In these cases, distal perfusion can be provided with introducer sheath (4). In emergency cases, time is important and percutaneous techniques are preferred. In our case, percutaneous techniques were preferred because time limitation was important. The right femoral artery was preferred for arterial cannulation and the left femoral vein was preferred for venous cannulation. Because of direct cannulation, distal perfusion was achieved with 9F sheath to avoid distal ischemia. Peripheral ECMO may develop vascular complications related to cannulation site. Acute extremity ischemia and bleeding are the most common complications (5). There was no complication related to cannulation site in our

case. The other route used for peripheral arterial cannulation in peripheral ECMO applications is the subclavian artery. In patients with VA ECMO who underwent subclavian artery cannulation due to flow direction, renal perfusion and upper body parts were shown to be better perfused. In peripheral VA ECMO, femoral artery cannulation for arterial cannulation is not a highly desirable method for brain and myocardial perfusion. In the subclavian artery cannulation, nerve damage can also be seen as a vascular complication. We prefer the subclavian artery for arterial cannulation in elective VA ECMO implantations (with graft). However, the subclavian artery could not be used due to time constraint in our case.

In our case, no systemic complications (renal failure, central nervous system complications, etc.) were observed with femoral artery cannulation.

ECMO provides non-pulsatile continuous flow. If peripheral arterial cannulation is performed on the femoral artery, ECMO will provide continuous retrograde flow in both systole and diastole. Therefore, cerebral, coronary and renal perfusion will vary depending on whether the heart generates pulsatile flow or not. The perfusion pressures will become quite complex if the event is joined by the IABP. If the heart does not generate adequate flow rate, IABP (femoral artery-mediated) will decrease cerebral and coronary perfusion, since cerebral and coronary perfusion will be completely ECMO dependent (due to descending aortic occlusion in diastole by the IABP). IABP will increase cerebral blood flow when the heart is ejecting properly (7). For this reason, it is very important that the heart is adequately operated in patients with peripheral ECMO with IABP. In our case, we achieved cardiac sinus rhythm within 10 minutes after implantation of peripheral ECMO and no neurological complications were detected.

As a result, direct VA ECMO implantation (e-CPR) is an important alternative treatment method in patients with postcardiotomy sudden cardiac arrest.

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