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A simple method of vascular access to perform emergency coronary angiography in patients with veno-arterial extracorporeal membrane oxygenation

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Abstract *Purpose:* Veno-arterial extracorporeal membrane oxygenation (V-A ECMO) is progressively used in severe cardiogenic shock or in-hospital resuscitation to stabilize patients and to bridge to further therapeutic interventions. However, vascular access for coronary catheterization can be difficult under these conditions. It would thus be desirable to use arterial lines that are already inserted. Here, we describe a novel technique to perform coronary angiography and angioplasty in patients with V-A ECMO. *Methods:* The technique is described in five patients in whom V-A ECMO was established because of prolonged cardiopulmonary resuscitation and who underwent coronary catheterization after stabilization. At the arterial cannula of the ECMO, a Y connector was inserted. At its free end, a hemostatic valve was placed, over which the coronary catheters were inserted. *Results:* In one case, diagnostic coronary angiography revealed no significant coronary stenosis. In four other cases, successful coronary angioplasty with and without stent implantation was performed. *Conclusion:* Cardiac catheterization using a Y-shaped adapter introduced into the arterial ECMO cannula is feasible. In a resuscitation setting, a new puncture of the femoral artery always carries the risk of complications, wherefore this new technology can be regarded as fast alternative.

Keywords ECMO · Coronary angiography · Cardiopulmonary resuscitation

Introduction

Extracorporeal membrane oxygenation (ECMO) is increasingly becoming a bridge therapy in patients with profound cardiogenic shock and in the setting of prolonged cardiovascular resuscitation [1, 2]. In the majority of cases, acute cardiogenic shock is caused by acute coronary occlusion. The time taken to restore the coronary flow is deemed of vital importance, as the SHOCK trial showed improved 6-month and 6-year survival in patients randomized to early coronary revascularization [3, 4]. Reports describe the successful implementation of ECMO in patients with cardiogenic shock undergoing coronary angioplasty [5, 6]. Recently a study in patients with ST-segment elevation myocardial infarction reported that early ECMO-assisted primary percutaneous coronary intervention was associated with superior 30-day outcome [7].

However, in patients with cardiogenic shock and ECMO therapy, vascular access for coronary angiography is a challenge for the following reasons. First, blood pressure (and with ECMO especially pulse pressure) tends to be low making it difficult to puncture an artery, particularly the radial artery. Second, usually one femoral artery is occupied by the ECMO backflow cannula. Third, the venous ECMO cannula is often situated on the

contralateral groin. Thus, arterial puncture for coronary angiography may prove difficult and time consuming in patients with cardiogenic shock and ECMO. Furthermore, unsuccessful puncture attempts may lead to severe bleeding complications. Hence, we developed a new method of arterial access for coronary angiography and angioplasty via the femoral arterial ECMO cannula, which was successfully performed in five patients.

Case reports and technique

In the first case, a 73-year-old patient with a history of aortocoronary bypass surgery was operated on for severe bilateral carotid stenosis. At the end of the surgical intervention, the patient's hemodynamic parameters deteriorated rapidly with the need for cardiopulmonary resuscitation (CPR). A sufficient circulation could not be established and it was decided to implant a V-A ECMO system. The arterial cannula (Art. HLS cannula 17 Fr, length 15 cm, Maquet CP, Germany) was inserted percutaneously by Seldinger technique during CPR in the right femoral artery and the venous cannula (21 Fr, length 35 cm) was inserted in the left femoral vein. Following ECMO implantation, the patient was transferred to the catheterization laboratory for further diagnostic evaluation. Coronary angiography was performed via the arterial ECMO cannula and revealed the aortic-coronary bypasses open, excluding coronary ischemia as the cause of the circulatory failure.

In the second case, a 50-year-old patient presented with chest pain at his general practitioner. The 12-lead ECG revealed inferior ST-segment elevation. Before transfer to the hospital, the patient suffered a cardiac arrest. CPR was initiated. Since it was not possible to establish a sufficient circulation, a rescue team from our hospital was involved and implanted a V-A ECMO system in the rooms of the general practitioner, as has been reported previously [8]. The arterial cannula was implanted into the right femoral artery and the venous cannula was implanted into the left femoral vein. With ECMO support the patient was transferred to the cardiac catheterization laboratory. The subsequent coronary angiography was performed via the arterial ECMO cannula and revealed an acute occlusion of the proximal right coronary artery. This was successfully recanalized, PCI (percutaneous coronary intervention) performed, and a bare-metal stent implanted. The angiographic result was excellent and the patient was transferred on ECMO to the intensive care unit.

In the third case, the resuscitation of a 40-year-old male took place close to our hospital. Both primary and emergency care was available within a very short period of time. After defibrillation, sinus rhythm was achieved, but after 5 min it deteriorated again to ventricular tachycardia. After second defibrillation, a stable sinus rhythm was established. Despite stable rhythm, no sufficient circulation was achieved, and the patient was transferred under resuscitation conditions to our emergency room. Here, an ECMO was inserted by a team of cardiac surgeons and cardiopulmonary technicians, who were already available. After stabilization of the circulation, the patient was transferred to our cardiac catheterization laboratory. An occluded right coronary artery was successfully reopened over the ECMO cannula using the Y connector.

In the fourth case, a 60-year-old male was resuscitated out of hospital. Primary resuscitation was initiated immediately. However, after arrival of the emergency team, ventricular fibrillation could not be terminated and the patient was transferred under mechanical CPR to our emergency room. An ECMO was inserted in the left groin and the patient transferred to our catheterization laboratory. Angiography was performed using the Y connector. Because of the large size of the patient together with the Y connector, extra-long catheters (125 cm) had to be used. An occluded left anterior descending (LAD) artery was reopened resulting in Thrombolysis in Myocardial Infarction (TIMI) II flow.

In the fifth case, a 48-year-old male was resuscitated immediately. After stabilization the patient was transferred to the next hospital with a coronary catheter laboratory. Angiography revealed an occluded right coronary artery as well as a severe stenosis of the main stem. Revascularization of the right coronary artery failed. Subsequently, PCI of the main stem was performed and a drug-eluting stent implanted. Because of hemodynamic deterioration an ECMO was inserted in the left groin. The patient was then transferred to our hospital and was weaned from the ECMO. Ten days after the first infarction the hemodynamic situation suddenly deteriorated again and required resuscitation. During resuscitation an ECMO was again inserted into the right groin. Because of difficult access, a 15-Fr arterial cannula was used. Angiography was performed using the Y connector and revealed a large in-stent thrombus of the main stem, which was successfully treated by PCI.

In all five cases, a standard Y connector was inserted into the arterial cannula of the ECMO line close to the patient (see Figs. 1, 2). The blind end was equipped with a hemostatic valve (Check-Flo Performer accessory adapter, Cook Medical, USA). This was used in a standard manner to insert the coronary catheters. Since there was no change in lumen, the hemodynamic situation was not influenced by the Y connector. However, the insertion of a coronary catheter reduces the effective lumen of the ECMO cannula. The internal lumen of the 17-Fr cannula is 18.47 mm^2, which is reduced by a 6-Fr catheter by 3.14 mm^2, resulting in a relative decrease of 17%. In all four cases using a 17-Fr cannula, the consecutive decrease of ECMO flow could be effectively counterbalanced by an increase of rotational speed of the ECMO. In the last

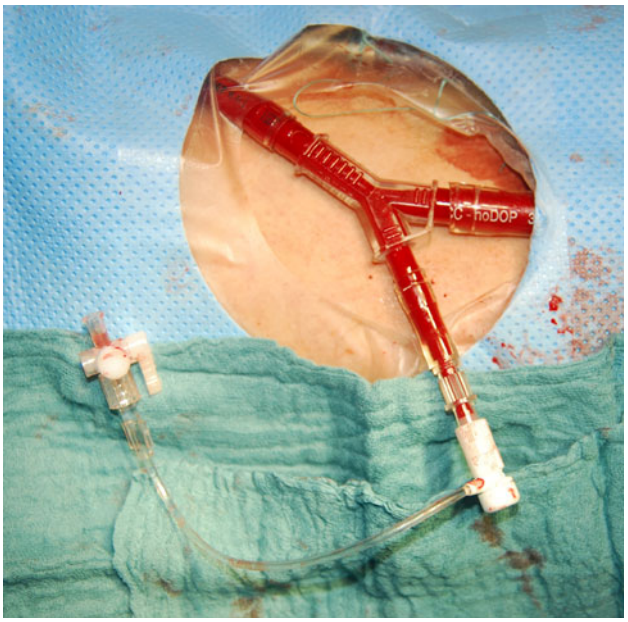

Fig. 1 Y connector inserted in the arterial line. Picture taken after coronary catheterization

Fig. 2 Overview over arterial (*left*) and venous (*right*) ECMO line after cardiac catheterization. The arterial line is equipped with the Y connector

case using a 15-Fr cannula, the ECMO flow decreased from 3.4 to 2.6 L/min. However, together with the low output of the patient this was well tolerable for the time of coronary intervention and evidently the neurologic outcome of this patient was excellent.

To ensure appropriate sterile conditions, the Y connector was inserted either within the procedure of ECMO implantation or within the procedure of angiography. If the ECMO is needed for a longer time, we suggest removing the Y connector to avoid hemostasis in the blind end of the Y connector. Moreover, the time between insertion of the Y connector and angiography should be short to ensure that no blood clot can be introduced into the arterial system.

Moreover, it needs to be mentioned that patients with V-A ECMO may develop critical limb ischemia [9]. In this case the device may provide an additional advantage, as it could be used as bypass if the patient needs a peripheral perfusion cannula.

Conclusion

Coronary angiography and angioplasty can be performed easily via the arterial ECMO cannula using a Y connector and a hemostatic valve. Because arterial access in patients with cardiogenic shock can prove difficult, this approach saves valuable time and may prevent complications due to unsuccessful punctures and thus may provide a safe alternative. However, we have to acknowledge that the number of cases is still low and more experience with this approach has to be gathered.

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