How-to-do-it

How to perform a haemodialysis using the arterial and venous lines of an extracorporeal life support

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Abstract

Continuous renal replacement therapy is particularly suited in the setting of acute renal failure, occurring after cardiac surgery, in patients requiring extracorporeal life support (ECLS) or membrane oxygenation. In such patients, temporary catheters are not necessary since the circuit of haemodialysis or haemofiltration may be connected on the ECLS cannulae. We report how to modify a classical ECLS circuit to connect directly the haemodialysis (Prismaflex device, Gambro-Hospal, Lyon, France) to the ECLS. We also detail parameters used to initiate the haemodialysis. Actually, we modify all our ECLS circuits as described here, at implantation time, allowing rapid haemodialysis initiations. Since 2004, 21 patients have been treated, as described here, without supplemental mortality or related complication.

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In the past few years, the extracorporeal life support (ECLS) is being used more frequently to assist adult patients presenting acute cardiac and pulmonary dysfunctions [1]. This support can be easily initiated and allows, in some cases, a rapid recovery of organ functions. However, frequently, this recovery is usually progressive and a continuous renal replacement therapy (haemodialysis) may be required [2]. From our experience, we can state that more than 75% of our patients need a temporary haemodialysis or haemofiltration without delay. We use Prismaflex devices (Gambro-Hospal, Lyon, France) including a Prisma set (AN69HF hollow fiber hemofilter/dialyzer) allowing regular haemodialysis.

The classical solution to initiate the haemodialysis is to place a specific double-way venous catheter. The most frequent venous accesses used are the internal jugular and subclavian veins. The femoral vein is less frequently chosen, due to the septic risk, and the potential risk of thrombosis in the neighbourhood of the ECLS cannulae. However, in our institution, we have imagined a very simple venous access: the ECLS itself.

Similarly to many surgeons and anaesthesiologists, we have connected the inflow catheter of the haemodialysis to the venous line, and the outflow to the arterial line of ECLS (Circuit ECMO type Reims, Deltastream pump, Medos, France). Despite this 'logical' implantation, no haemodialysis was possible due to a permanent alarm of pressure.

To understand why our first experience was a failure, we have analysed all pressures in the venous and arterial lines of the ECLS, before and after the pump and the oxygenator. This analysis reports that in many cases, the pressure in the venous line is null or negative, generating a suction with a risk of gas embolism. This venous pressure is frequently negative during hypovolaemia and can induce important variations of blood flow rate of the assistance. Between the pump and the oxygenator, the pressure is the highest because of the constitutive resistance of the oxygenator. The pressure in the arterial line of the ECLS is high because of the blood acceleration by the pump and of the arterial resistance of the patient.

These conclusions lead us to imagine an 'illogical' but original and very simple solution to connect the haemodialysis on the venous and arterial lines of the ECLS. The inflow of the haemodialysis is connected to the arterial line, and the outflow is connected to the venous line using two 3-way taps (Luer Lock) (Fig. 1). Using these connections, the pressure in the arterial line (mean arterial pressure: 74 mmHg) allows an optimal inflow. Furthermore, since the pressure is low in the venous line, there is no resistance in the outflow catheter. Thus, the haemodialysis can be "classically" performed.

All haemodialysis parameters are chosen to correct the fluid overload, to control azotemia, serum potassium and to restore the acid–base balance. All these goals are provided using either convective (haemofiltration) or diffusive (hae-
modialysis) techniques following classical safety precautions concerning dialysis.

Since 2004, 21 patients have been treated as described here, without supplemental morbidity, mortality or related complication. No difference was shown concerning biological parameters and renal function recovery. At the initiation time of the haemodialysis, main creatinine and urea blood levels were, respectively, 358 μmol l⁻¹ and 32 mmol l⁻¹ and 146 μmol l⁻¹ and 11 mmol l⁻¹ at the dialysis discontinuation. However, using our method, we have observed a shorter delay to initiate the dialysis and, as a consequence, a more precocious stabilisation of the renal function.

Discussion

Due to the constant low cardiac output before the ECLS implantation, the haemodialysis is frequently required at the time of the assistance initiation [3]. The multiplication of arterial and venous accesses increases the risk of sepsis and death [4] and needs regular replacements. Moreover, the risk of local thrombosis is also important [5]. For these reasons, since 2004, the haemodialysis connection for patients under cardiac assist has been done using the ECLS circuit. No thrombo-embolic or septic complications have been related to this method. No modification was induced considering haemodialysis setting and biological results. The quicker recovery of the renal function, observed in our practice, is essentially related to the precocious initiation of the haemodialysis or haemofiltration and not due to the type of ‘blood access’ used.

This reported technique is simple, reliable and safe. It only requires two adapted connectors with a three-way tap on each. Despite the absence of problems related to this modification in our institution, all nurses must be alerted to the risk of gas embolism due to the potential negative pressure in the venous line. This is also the case for all circuits of mini-extracorporeal circulation, similar in the concept, to the ECLS.

In summary, during a haemodialysis, the arterial blood is taken from the corresponding line and re-injected by the venous line, creating a shunt due to the recirculation of the haemodialysed blood in the ECLS. In practice, the haemodialysis needs a stable blood flow rate between 150 ml min⁻¹ and 180 ml min⁻¹ and filtration flow rates ranges from 30 ml min⁻¹ to 40 ml min⁻¹ to provide an adequate urea clearance. Therefore, it can be overlooked because of the performance of the actual ECLS (mean blood flow: 3.9 l min⁻¹).

In the same way, during the femoral implantation of ECLS, we have attempted to connect the catheters of haemodialysis and for the distal revascularisation of the leg on the same three-way tap without success. The cause of the dysfunction is the very low flow in both catheters. We now connect these different catheters on two distinct connectors. To standardise this technique, the modification is now done by our ECLS manufacturer.

Finally, the cost of this modification is very low and will always be less than the cost of a specific dialysis catheter, its surveillance and its regular replacements.

References