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Impact and Management under Extracorporeal Circulation of a Patient with Renal Insufficiency on Dialysis with a High-Flow Arteriovenous Fistula in the Cardiac Surgery Department of the Angers Teaching Hospital about a Case and Review of the Literature

Abdoulaye Kanté[1,2*], Bréhima Coulibaly[1], Mamadou Diakité[3], Mamadou A. Keita[1], Bakary Keita[4], Drissa Traoré[1], Nouhoum Ongoïba[1], Patrice Binuani[2], Christophe Baufreton[2]

[1]Department of Thoracic and CardiovascularSurgery, CHU Point G, Bamako, Mali
[2]Cardiac Surgery Department of the University Hospital of Angers, Angers, France
[3]Cardiology Department, CHU Point G, Bamako, Mali
[4]Commune II Reference Health Center, Bamako, Mali
Email: *kanteim@yahoo.fr

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Abstract

Arteriovenous fistulas have a substantial impact on systemic hemodynamics, however their effect on extracorporeal circulation is not well understood. We report our clinical observation on the management under extracorporeal circulation of a patient with renal insufficiency with a high-flow arteriovenous fistula. This is a 59-year-old man who was referred to us for surgical treatment of ischemic coronary artery disease in a context of anuric chronic renal failure. Hypothermia at 32˚C is started from the start in CEC due to hyperflow at the level of the arteriovenous fistula. We performed two coronary artery bypasses of the marginal and IVA via the two internal thoracic arteries. The patient is hemofiltered in order to avoid hyperkalaemia and possibly avoid fluid overload related to filling per CEC. The clamping time was 71 minutes and the SCC lasted 141 minutes. There was no homologous transfusion in the operating room. It turns out that the input/output balance is zero at the end of the CEC. The postoperative course was simple.

Keywords

Coronaryartery by Pass Grafting, High Flow Arteriovenous Fistula, Extracorporeal Circulation, Hypothermia

1. Introduction

An increasing number of renal dialysis patients with an arteriovenous fistula are undergoing cardiac surgery [1].

Arteriovenous fistulas have a substantial impact on systemic hemodynamics, however their effect on extracorporeal circulation is not well understood.

The left-to-right shunt of blood through an arteriovenous fistula could create a flow problem during cardiopulmonary bypass [2].

But above all, it can distort the results observed on the gasometry per CEC (abnormally high Svo2 for example, inducing an excess of confidence in the reading of the parameters of the CEC and therefore for the conduct of it.

The observations of isolated cases on the difficulty of the management of patients with arteriovenous fistula, during cardiopulmonary bypass have been published [1] [2].

In order to contribute to enrich the literature, we report our clinical observation.

2. Clinical Observation

This is a 59-year-old man who was referred to us for surgical treatment of ischemic coronary artery disease in a context of anuric chronic renal failure.

Her medical history was high blood pressure, dyslipidemia, and anuric chronic renal failure on dialysis three times a week.

His surgical history was a radical left nephrectomy for papillary carcinoma.

The history of his ischemic coronary artery disease goes back to the discovery of an alteration of the LVEF during a cardiological assessment carried out in the context of his chronic renal insufficiency. Indeed, the echocardiography showed an alteration of the left ventricular ejection fraction at 45%, apical akinesia, anteroseptal hypokinesia and a DTDVG at 56 mm.

Coronary angiography revealed bi-vessel coronary involvement with chronic IVA occlusion and significant first marginal stenosis. It was decided to perform endovascular treatment because of a poor quality downstream bed. Two active stents are implanted on the IVA but the procedure is complicated with probable dissection of the IVA later. Therefore, the indication for surgical revascularization by double bypass was confirmed.

Doppler ultrasound of the supra-aortic trunks revealed bilateral calcified atheroma at the subclinical stage.

Doppler ultrasound of the pelvic limbs showed diffuse calcifying arteriopathy of the pelvic limbs with a bilateral proximal predominance, well compensated.

The patient goes to the block on 01/27/2022 for management of his ischemic coronary artery disease. When he entered the operating room and faced with the fact that the flow of his fistula had not been documented, the surgery was postponed.

Ultrasound of the arteriovenous fistula evaluated the flow rate of the fistula at 1450 ml.

He returns to the block on 01/31/2022.

After collegial discussion (surgeon/anaesthesiologist - resuscitator/perfusionist), hypothermia at 32˚C is decided.

Extracorporeal Circulation Procedure:

The circuit of CEC is a biocompatible phisio 1/2 3/8 "liva nova". Debubbling is classic 1500 ml of Gelofusine and 200 ml of mannitol.

After the median sternotomy and the opening of the pericardium, the cardiac chambers were discreetly increased. We removed the two internal thoracic arteries. They were kept in a compress soaked in warm serum and PAPVERINE during the installation of the extracorporeal circulation.

We installed extracorporeal circulation between the ascending aorta and an atriocaval cannula, left ventricular discharge through the right pulmonary vein.

CEC at full flow, we clamped the aorta and injected cold blood cardioplegia into the ascending aorta. It was subsequently renewed once.

Hypothermia at 32˚C is started from the start in CEC due to hyperflow at the level of the arteriovenous fistula. The anesthesiologist injects 500 mg of thiopental for cerebral protection.

At the start of the CEC, the cardiac output is easily ensured. This allows the SVO2 and the DO2i to be within the standards.

On the other hand, very quickly, during the realization of the two bypasses on the IVA and the marginal, the gene of the venous return no longer allows to ensure a sufficient flow and clearly results in an insufficient DO2i (fall up to 239).

Hypothermia compensates for this cellular hypoxia by significantly reducing cell needs.

The patient is hemofiltered in order to avoid hyperkalaemia and possibly avoid fluid overload related to filling per CEC.

We performed warm reperfusion cardioplegia with 200 cc of blood before aortic declamping. The heart restarts in junctional rhythm and then fairly quickly recovers a stable sinus rhythm. Once the temperature of about 36˚C was reached, we purged the heart chambers and gradually stopped the CEC under small doses of NORADRENALINE after optimizing the filling.

The clamping time was 71 minutes and the SCC lasted 141 minutes.

There was no homologous transfusion in the operating room. It turns out that the input/output balance is zero at the end of the CEC.

The postoperative course in Surgical Resuscitation and Cardiac Surgery was simple. Indeed, the patient was extubated early without respiratory complications. He had no ischemic complications. He had three hemodialysis sessions on AVF and had an ACFA episode, reduced after volume expansion. During hospitalization, there is deglobulization without exteriorized bleeding requiring the transfusion of an RCC and administration of EPO three times a week.

3. Discussion

Hemodialysis-dependent patients undergoing heart surgery present many chal-

lenges for physicians, and these challenges are well documented [1]. The creation of a hemodialysis AVF has a significant impact on cardiovascular hemodynamics. Increased flow through the AVF can lead to a cascade of complications including increased cardiac and pulmonary arterial pressures, myocardial decompensation, decreased left ventricular function, and ultimately high-output heart failure (defined by a cardiac index of 4 L/min/m^2 associated with symptoms of heart failure [1].

However, studies on the effects of a surgically created AVF during CPB are few [2] [3].

The impact of surgically created AVFs on bypass graft function has been observed in several studies. [4] [5] [6]

A thoracic limb fistula and an ipsilateral internal thoracic artery (ATI) arise from the same vascular root. Therefore, left-to-right shunt through the AVF can potentially reduce ipsilateral internal thoracic artery flow, which can lead to internal thoracic artery theft and subsequently reduced coronary flow after revascularization by ATI. Using transthoracic color Doppler ultrasound imaging, Rahbar and colleagues [4] analyzed internal thoracic artery flow changes in patients with thoracic limb AVFs and concluded that these AVFs have a modest hemodynamic effect on the internal thoracic artery in situ. Kato *et al*. [5] showed the steal phenomenon with the use of angiography in the left internal thoracic artery during diastole and decided to use the right internal thoracic artery in their patient.

Nyawo and colleagues [3] reported the effects of an AVF during CPB. They focused on compromised coronary perfusion caused by a large proximal AVF with high flow, which led to unsuccessful attempts to wean their patient from CPB. They explored and tied the fistula, and then successfully weaned the patient from CPB. Their case highlights the possibility of adverse effects of an AVF during CPB.

However, in the absence of high-output heart failure, we believe that AVF closure should only be considered as a last resort.

Cetin *et al*. [7] reported the effects of a high-flow arteriovenous fistula on the administration of cardioplegia and myocardial protection during coronary artery bypass grafting in a dialysis patient. Indeed, excessive venous return via a high-flow AVF can reheat the myocardium, so that the delivered cardioplegic solution does not stop the heart, and inadequate myocardial protection could result. They set up a double upper and lower venous cannulation and prevented the cardiac distention caused by the left-to-right shunt through the arteriovenous fistula.

The possible effects of an AVF on hemodynamic values during SCC require further investigation. To our knowledge, ours is the first study to highlight the effect of a high-flow arteriovenous fistula on DO2i during coronary artery bypass grafting in a patient with end-stage renal disease with AVF.

We adopted the strategy of moderate hypothermia in order to reduce the

needs of the cells.

4. Conclusions

The arteriovenous fistula acts as a recirculation regarding the extracorporeal circulation and the perfusionist must overcompensate the flow of the fistula in order to arrive at the theoretical flow of the patient.

Hypothermia is a simple way to prevent cellular hypoxia following the decrease in cardiac output.

This moderate hypothermia should be considered for patients on dialysis with a high-flow arteriovenous fistula undergoing cardiac surgery.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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