Case report - Assisted circulation

Place of extracorporeal membrane oxygenation in acute aortic dissection

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Abstract

Coronary artery dissection (CAD) is a rare but serious complication of type A aortic dissection (AD) which may be discovered preoperatively in the presence of clinical or ECG signs of ischemia, or intraoperatively after dissection of the coronary ostium. Treatment of CAD consists of surgical repair with glue and, if necessary, coronary artery bypass graft. No case of AD with CAD complicated by major arrhythmias treated by assisted circulation has been reported in the literature. We report the first case of AD with implementation of extracorporeal membranous oxygenation following cardiotomy with a favorable outcome.

Keywords: Coronary disease; Mechanical circulatory assistance; Great vessels; Extra-corporeal circulation

1. Clinical summary

A 45-year-old woman presented at the emergency department with sudden onset of epigastric pain radiating to the interscapular region. A contrast-enhanced computed tomography (CT) scan of her chest and abdomen revealed an acute type A aortic dissection (AD) according to Stanford classification extending to the right femoral artery and left iliac artery (Fig. 1). An electrocardiogram (ECG) revealed sinus bradycardia with repolarization defects in the inferior territory.

The decision was made to carry out emergency surgery. Hypothermic (22 °C) cardiopulmonary bypass (CPB) with left femoral artery and atio caval venous cannulations was performed. Cold blood retrograde cardioplegia was performed. Dissection was extended to the two coronary ostia without other intimal tear. A Bentall procedure with mechanical valve (Saint Jude Medical, MN, USA) was performed after gluing the coronary ostia associated with the total replacement of the aortic arch.

Assisted circulation was resumed following the sudden onset of ventricular arrhythmia at the end of the operation, not controlled by internal electrical cardioversion and antiarrhythmics. Due to the strong suspicion of right coronary artery (RCA) dissection, a coronary artery bypass graft (CABG) was performed using a saphenous vein graft on segment 2 of the RCA. Left femoro-femoral extracorporeal membrane oxygenation (ECMO) (Quadrox, Maquet, Orléans, France) was then initiated due to persistence of arrhythmias and hemodynamic instability despite satisfactory revascularization by the CABG. At the end of the operation, hemodynamic parameters were satisfactory with ECMO and vasopressor amines. Postoperative peak troponin Ic was 410 ng/ml.

The first postoperative echocardiography demonstrated posterolateral and apical akinesia with a left ventricular ejection fraction (LVEF) of 18%. The clinical course was rapidly favorable with improvement of the LVEF (50%). She was weaned from ECMO from day 5, artificial ventilation from day 6. She was discharged from the intensive care unit (ICU) at day 8 and from the hospital on day 29.

Postoperative coronary CT-scan demonstrated the patency of the saphenous graft with dissection of the proximal segment of the RCA (Fig. 2).

Her postoperative course was marked by homonymous hemianopsia related to an occipital ischemic stroke at the 20th postoperative day.

2. Comment

Coronary artery dissection (CAD) is a rare but serious complication of acute AD. It may be discovered at the same time or may be the presenting sign of AD [1]. Several studies have shown that the RCA, particularly its proximal part [2], is more frequently affected. CAD is characterized by ECG signs, elevation of cardiac enzymes and/or myocardial dysfunction [3]. CADs are sometimes diagnosed during coronary angiography, which reveals an intimal flap occluding the artery. In our case, RCA dissection was already suspected on the patient’s arrival in the operating room due to the presence of ischemic signs on ECG. However, the patient presented with ventricular arrhythmias requiring resumption of assisted circulation to perform a CABG. The preoperative presence of ischemic signs must be taken into account when performing the aortic root replacement.

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procedure, as these signs reflect coronary malperfusion requiring glue repair of the ostia and/or CABG. However, no preoperative predictive factor is associated with a decreased risk of coronary malperfusion syndrome [3]. In the present case, the CABG failed to restore normal ventricular function, as the arrhythmias persisted. The only option was to continue assisted circulation to allow myocardial recovery. The clinical and ECG course was very favorable after initiation of ECMO. The initial CT-scan showed a type A AD extending to the right femoral artery with no involvement of the left femoral artery, which guided the initial choice of arterial cannulation for CPB. This type of cannulation is associated with a risk of potential deterioration of the dissection lesions in the rest of the aorta and a risk of retrograde dissection of arteries supplying the brain [4]. The second risk is mobilization of aortic calcifications resulting in cerebral emboli. Many surgical teams prefer axillary artery cannulation as it ensures a continuous cerebral blood supply without requiring circulatory arrest [4], as deep hypothermic circulatory arrest is associated with an increased risk of postoperative neurological sequelae and mortality [5]. Furthermore, when CT shows the absence of dissection of the axillary artery, cannulation of this artery decreases the risk of vascularizing the false lumen, which would worsen the dissection. However, the axillary surgical approach is more difficult, and therefore appears to be less suitable for emergency cannulation. Femoral artery cannulation was preferred in our patient as CPB had to be performed urgently.

The use of peripheral ECMO in patients with AD can induce specific complications. Once the entry tear has been excluded, there is still a very low theoretical risk of retrograde dissection from a second entry tear. This risk is lower in the case of axillary artery cannulation associated with antegrade flow [6]. However, femoral artery cannulation was the most appropriate solution in this case due to the urgent need for assisted circulation.

Selective perfusion of one lumen may be observed, but not necessarily the lumen supplying the gastrointestinal or renal arteries, resulting in signs of tissue malperfusion which is associated with higher in-hospital mortality [3].

The main neurological risk of AD with ECMO is probably retrograde dissection to arteries supplying cerebral vessels, resulting in ischemic stroke. Several studies have shown that neurological complications are due to impaired cerebral blood supply, but failed to demonstrate any significant difference between groups according to retrograde or antegrade cerebral perfusion [7]. In contrast, the rate of neurological complications has been shown to be lower when cerebral perfusion is performed under deep hypothermia. Our patient suffered an ischemic stroke in the vertebral artery territory due to embolism or dissection despite optimal brain protection and hypothermia. Some studies suggest that postoperative ischemic strokes are mainly embolic, due to retrograde perfusion via the femoral artery [7], while others claim that neurological complications are correlated with the duration of deep hypothermic circulatory arrest [8].

This is the first report of AD complicated by CAD requiring post-cardiotomy ECMO with a favorable outcome. This case illustrates the value of assisted circulation in AD associated with severe perioperative myocardial ischemia, as ECMO ensures stable hemodynamics allowing myocardial recovery, despite the theoretical risk of retrograde dissection and neurological complications.

References

eComment: Management of type A aortic dissection complicated by coronary ischemia

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We read with great interest the article by Doguet et al. concerning the successful use of extracorporeal membrane oxygenation (ECMO) in a patient operated for acute type A aortic dissection (AAAD) and suffering from myocardial ischemia due to the dissection of the right coronary cusp [1]. Myocardial ischemia secondary to AAAD is known to dramatically increase the mortality associated with surgical repair. However, there are two points regarding the surgical management the authors described that we would like to comment upon.

First, the authors noted that they used retrograde cardioplegia as a mean of myocardial protection. One of the main drawbacks of retrograde cardioplegia is precisely the fact that it does not protect correctly the territory of the right coronary artery (RCA) [2], and thus it is advisable to associate it with antegrade cardioplegia to the RCA, either via the right coronary ostium or through a saphenous graft. As the preoperative electrocardiogram showed signs of myocardial ischemia in the RCA territory prior to the operation, our attitude would have been to perform the saphenous graft to the RCA as soon as possible during the cooling phase of cardiopulmonary bypass. This graft would have served as a conduit for reperfusion of blood via a derivation from the arterial line, thus limiting the ischemic insult to the myocardial territory of the RCA, and then, after inducing hypothermic circulatory arrest, protect the heart by combining retrograde and right coronary antegrade cold cardioplegia.

Second, it is usually advisable, once the aortic repair has been performed, to perfuse the aorta for the rewarming period in an antegrade fashion either through the aortic Dacron graft or through the axillary artery in case the latter has been previously chosen as an arterial cannulation site. The goal of this is to avoid continuous retrograde perfusion of a dissected descending aorta. We agree with the authors about the fact that femoral cannulation is easier and faster to perform when the patient is suffering from an unstable hemodynamic condition; however, we think that while on cardiopulmonary bypass, a 2-cm Dacron side-graft to the right axillary artery would have better served as an arterial cannulation site for the ECMO arterial cannula. The wound closed over the Dacron side-graft minimizes the risk of bacterial contamination.

References