Alternative myocardial protection strategies are necessary in patients with intramural aortic course of anomalous coronary artery

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SUMMARY

A 48-year old Caucasian woman presented with chest pain on exertion and was diagnosed with an anomalous origin of dominant right coronary artery, it then ran a short intramural course in the wall of the aorta. Right coronary artery (RCA) was reimplanted on cardiac bypass at normal exit point on the aortic root. The heart was adequately protected with antegrade cold blood cardioplegia via the aortic root and regular direct cardioplegia via the coronary ostia. The patient could not come off cardiopulmonary bypass after surgery and required right ventricular assist device support to be weaned from cardiopulmonary bypass. The patient ultimately recovered well and her right heart function is normalising.

We believe that antegrade cardioplegia via the aortic root caused increased pressure in the aorta and squashed RCA in the wall of the aorta causing failure of myocardial protection and stunning of the right ventricle. This could be prevented with alternative myocardial protection strategies like direct cardioplegia via the coronary ostium.

BACKGROUND

We present a case of failure of myocardial protection with antegrade delivery of blood cardioplegia via the aortic root in a patient with anomalous origin of the right coronary artery (RCA). The patient required a right ventricular assist device (RVAD) to be weaned from cardiopulmonary bypass although ultimately she recovered well. Additional myocardial protection strategies are necessary if antegrade aortic root cardioplegia is administered in a patient with an intramural aortic course of an anomalous coronary artery.

CASE PRESENTATION

A 48-year-old Caucasian woman presented with chest pain on exertion.

INVESTIGATIONS

A CT angiogram showed normal left coronary artery (LCA) but anomalous origin of dominant RCA immediately above the left main stem (LMS) from left coronary sinus, it then ran a short intramural course in the wall of the aorta between the aorta and the pulmonary trunk (figure 1A). Angiography showed mild non-obstructive disease of RCA and confirmed anatomic variation. LCA was normal angiographically with no obstructive atheroma.

TREATMENT

Cardiopulmonary bypass (CPB) was instituted. After aortic cross clamping 1 litre antegrade cold blood cardioplegia was used via the aortic root. The RCA arose from a slit like origin at the ostium of the LMS. RCA was reimplanted at normal exit point on the aortic root with 5/0 prolene. Both right and left side of the heart were adequately protected during procedure initially with 1 litre of St Thomas solution via the aortic root as described before and then regular direct cardioplegia via the coronary ostia of 500 ml of St Thomas solution to left coronary ostium and 250 ml to right coronary ostium every 20 min. Pump time was 100 min with cross clamp time of 73 min.

After coming off bypass, the patient had runs of ventricular fibrillation, rising central venous pressure (CVP) and low systemic blood pressure (BP). CPB was reinstituted. Transthoracic echocardiogram showed impaired right ventricle (RV) function. As there was a concern that there may have been compromise of the reimplantation of RCA, the right internal mammary artery (RIMA) was harvested and a beating heart anastomosis to mid-RCA was performed. After RIMA to RCA bypass grafting repeated attempts to wean from CPB even with significant inotropic support failed. An intraaortic balloon pump (IABP) and RVAD were inserted to wean from CPB. Cumulative pump time was 230 min.

OUTCOME AND FOLLOW-UP

The patient remained stable postoperatively on moderate inotropic support. RVAD was weaned and removed on day 4 and IABP on day 6 and the patient was extubated on day 10 and was discharged on day 18 postoperatively. Initial post-discharge transthoracic echocardiogram showed impaired RV function but serial echocardiograms now show normalising RV function with the most recent showing near normal RV function.

A year after operation, a CT coronary angiogram shows normal native coronary arteries. The reimplanted RCA arises from the right coronary sinus and appears normal throughout its course (figure 1B). The RIMA graft to the RCA has occluded because of good competitive flow in the native artery. This result signifies good reimplantation of the native coronary artery.

DISCUSSION

We believe that antegrade cardioplegia via aortic root cannula caused increased pressure in the aorta and squashed the RCA in the wall of the aorta

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Figure 1 (A) A CT angiogram; showing normal left coronary artery but anomalous origin of dominant right coronary artery immediately above the left main stem, it then runs a short intramural course in the wall of the aorta between the aorta and the pulmonary artery. (B) CT angiogram of reimplanted right coronary artery.

- A CT angiogram; showing normal left coronary artery but anomalous origin of dominant Right coronary artery from just above the left main stem, it then runs a short course between aorta and pulmonary trunk.
- CT angiogram of re-implanted right coronary artery.

between the aorta and the pulmonary artery. RV did not get adequate cardioplegia during the initial 20 min after cross clamp causing stunning of the RV and consequently rising CVP and low BP on coming off bypass necessitating RVAD and IABP support.

Anomalous origin of the coronary arteries from the opposite coronary cusp and crossing the path between the aorta and the pulmonary artery are associated with angina, myocardial ischaemia and sudden cardiac death.^{1 2} Reimplantation of the anomalous coronary artery to normal sinus without unroofing the anomalous course of the coronary artery is an established option.⁴ Coronary artery bypass graft is also a well-discussed option,³⁻⁵ however occlusion of the graft due to competitive flow in the coronary artery has been documented.⁵

The delivery of cardioplegia by the aortic root results in a continuous systolic pressure in the aortic lumen which will compress the intramural portion of the RCA and precludes delivery of cardioplegia to the RV (figure 2). Although it is the author's usual practice to use retrograde delivery of cardioplegia in the coronary sinus in addition to antegrade cardioplegia, this may not have prevented the complication as RV protection is known to be suboptimal via the retrograde approach.

Literature search has not revealed any previous incidence of a problem caused by antegrade aortic root cardioplegia in patients with an anomalous aortic origin of the coronary artery with an intramural course in the aorta.

A coronary artery with anomalous intramural course in the aortic wall, running between the aorta and the pulmonary

Figure 2 A coronary artery with anomalous intramural course in the aortic wall, running between the aorta and the pulmonary artery could be compressed by increased pressure in the aortic root when antegrade aortic root cardioplegia is used.

A. Right coronary artery (RCA) with anomalous intramural course in the aortic wall.

B. Anomalous right coronary artery being compressed by increased pressure in the aortic root when antegrade aortic root cardioplegia is used.

artery could be compressed by increased pressure in the aortic root when antegrade aortic root cardioplegia is used (figure 2). This can have serious implications from stunning of myocardium to hibernation to even intraoperative myocardial infarction and death on table.

Learning point

- Preoperative delineation of these coronary artery anomalies can facilitate surgical planning and improve outcome. It is important to recognise these complications early and intervene quickly and effectively. This particular complication of antegrade aortic root cardioplegia to the anomalous coronary artery with intramural course in the aortic wall could be avoided if direct cardioplegia via the coronary ostium is used from the start of the procedure in conjunction with antegrade aortic root cardioplegia.

Competing interests None.

Patient consent Obtained.

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