Apicoaortic bypass for a patient with structural valve deterioration of a 19 mm bioprosthetic valve

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INTRODUCTION

Apicoaortic bypass (AAB) represents an alternative method to treat severe aortic stenosis in patients with a porcelain aorta or prior cardiac surgery, who are deemed to be at high risk for conventional aortic valve replacement (AVR) [1]. For our patient with structural valve deterioration (SVD), it was difficult to perform a redo AVR or trans-catheter aortic valve implantation (TAVI) because of a small aortic annulus. However, haemodynamic performance in the patient with SVD following AAB is uncertain, and there are some reports of thrombosis attributed to stagnation of native antegrade blood flow [2, 3]. This is the first report of AAB with SVD where the haemodynamics were evaluated by phase-contrast cine magnetic resonance imaging (PC-MRI).

CASE REPORT

A 79-year old male patient with peritoneal dialysis was admitted to our hospital with increasing symptoms of congestive heart failure. He had a 4-year earlier history of AVR with a 19 mm bioprosthetic valve (Carpentier-Edwards PERIMOUNT, Edwards Lifesciences, Irvine, CA, USA) and aortocoronary (A-C) bypass with saphenous vein graft to left anterior descending artery. Transthoracic echocardiography 1 year prior to the present admission had demonstrated an aortic valve peak gradient of 35 mmHg and an aortic valve area of 1.35 cm².

On this admission, transthoracic echocardiography showed severe AS with an aortic valve peak gradient of 99 mmHg, an aortic valve area of 0.54 cm² and a normal left ventricular ejection fraction. MRI and transoesophageal echocardiography revealed SVD, which might have been accelerated by the abnormal mineral metabolism owing to dialysis [4]. Computed tomography (CT) demonstrated that the A-C bypass was patent and there was little calcification in the descending aorta. Considering the small diameter of the aortic annulus, the existence of a previous A-C bypass and the high risk of reoperation, we opted for implanting an AAB. A posterolateral thoracotomy was performed through the fifth intercostal space. Cardiopulmonary bypass was initiated with femoral arterial and venous cannulation. End-to-side anastomosis of a 22 mm tube graft was sewn onto the descending aorta. After induction of electrical fibrillation, a plug of myocardium was removed with a coring device (Coring Knife, Jarvik Heart, New York, NY, USA). We used inverted graft insertion technique, which we had reported previously, to reinforce the proximal anastomosis [5]. A 23 mm stentless porcine valve (Prima Plus, Edwards Lifesciences) was sewn onto the short segment of 22 mm graft, which was pulled out from the apex. Finally, the distal end of the stentless porcine valve was sewn on the graft anastomosed to the descending aorta.

The postoperative course was uneventful. CT demonstrated an intact AAB and A-C bypass (Fig. 1). Haemodynamic evaluation was carried out by MRI 1 month after the operation. PC-MRI revealed a stroke volume of 22 ml (42%) for the native flow via the aortic valve, with 31 ml (58%) for the conduit flow. In the AAB, ascending aorta and aortic arch, blood flow was continuously antegrade during the entire cardiac cycle. In the descending aorta, blood flow was antegrade during systole, almost retrograde during diastole and to-and-fro in a small part of diastole (Fig. 2). Stagnation point was not observed clearly where flow velocity was zero during the entire cardiac cycle.

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DISCUSSION

Although TAVI is currently being investigated as an alternative therapy, AAB is an available therapy that provides good results [1] by avoiding the need for re-sternotomy, potential injury to patent grafts and manipulation of the ascending aorta. According to the PARTNER trial, TAVI also has exclusion criteria including a diameter of aortic annulus of less than 18 mm and a previous prosthetic valve [6]. In this case of SVD occurring in the smallest bioprosthetic valve, a redo AVR was complicated because it was difficult to exchange prosthetic valves of the same diameter; therefore, the second artificial valve tended to be smaller than the previous valve. It was also difficult to perform TAVI because our patient belonged to the exclusion criteria mentioned above. Therefore, the AAB was the optimal surgical method for this patient.

The patient’s postoperative haemodynamics were evaluated by PC-MRI. PC-MRI is the most suitable examination to evaluate the haemodynamics after the AAB, because it can measure all directional blood flows at any location in the artery accurately during the entire cardiac cycle [7].

PC-MRI revealed the bidirectional blood flow and no obvious stagnation in the descending aorta. However, it also revealed the to-and-fro blood flow in a small part of diastole. It is important to evaluate whether stagnation occurs, because the AAB is an anti-anatomical bypass. There have been some reports of thrombosis possibly caused by stagnation, and the necessity for anticoagulant therapy after AAB is controversial. Recently, Gammie et al. [8] reported that 31 patients were treated with 325 mg of aspirin alone after AAB, and no stroke episodes were encountered during the follow-up. On the other hand, Takahashi et al. [2] described that if patients have the potential to be complicated with a thrombus by flow competition after AAB, especially in cases with poor or decreasing LV function, strict anticoagulation therapies including warfarin and heparin should be initiated promptly after surgery in all cases. Considering the bleeding risk of these aged patients, we usually treat them with aspirin if there is no stagnation evaluated by PC-MRI. However, the to-and-fro blood flow effect on the haemodynamics is uncertain and it has been reported that the distribution of blood flow can change during the follow-up period [3], close observation is necessary in order to evaluate the haemodynamics at later follow-up times.

In summary, we herein presented a successful case of AAB with SVD, where the haemodynamics were evaluated by PC-MRI. Evaluation of potential stagnation is considered to be important.

Conflict of interest: none declared.

REFERENCES

We have read with interest the report by Domoto and colleagues [1]. Extra-anatomic aortic valve bypass (or apico-aortic conduit) has been adapted to selected high risk patients as an alternative to conventional aortic valve replacement and is based on the experimental work of Alexis Carrel [1–3]. Notably, at this time, cardiac surgery was limited to the treatment of penetrating wounds of the heart [3]. The poor results of thoracic surgery in the laboratory and in the theatre motivated Carrel to begin experiments with the hope of improving, or finding new surgical methods for the treatment of vascular and valvular diseases of the heart and aneurgysms of the thoracic aorta [3]. In an attempt to develop a technique of diverting the blood, whilst avoiding neurological complications, for the treatment of aneurysms of the thoracic aorta, he described both central and lateral diversion of the blood. Lateral diversion consisted of an anastomosis between the left ventricle and the descending aorta through a paraffined rubber tube or a jugular vein (preserved in cold storage) [3]. These experiments were carried out at the Rockefeller Institute for Medical Research, in New York, and he was awarded the Nobel Prize in Medicine in 1912 (the first one of its kind in USA).

In 1955, Sarnoff et al. developed the apico-aortic conduit concept further and were able to direct the entire cardiac output from the left ventricle to the thoracic aorta (in animals), using a Hufnagel valve in a lucite tube and permanently occluding the ascending aorta [4].

In 1973, Cooley reported on the 1962–1963 experience of Templeton who implanted Sarnoff’s prosthesis in five patients with one 10 year long-term survivor, and Cooley further popularised the apico-aortic conduit procedure [5].

Indications for aortic valve bypass surgery, apart from those reported by Domoto et al., include patients with previous complex cardiac operations (Calorel and homograft/root replacements) that preclude a safe re-sternotomy, sternal wound infection, regional radiotherapy, failed aortic annular augmentation procedures and patients with complex congenital LV outflow obstruction [1,2]. Specific complications include bleeding, thrombus formation in the aorta, hence the need for anticoagulation or antiplatelet treatment, as well as formation of pseudo-aneurysm or dehiscence from the UV apex in a number of patients [1,2].

Today, with the advent of transcatheter aortic valve implantation (TAVI), the need for the more invasive apico-aortic conduit approach has significantly diminished, but still remains an option for a few complex patients in whom TAVI is not an option.

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References


