






# Combined heart transplantation and replacement of atheromatous proximal arch

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## Abstract

Concomitant surgery on the aortic arch with hypothermic cardiac arrest in the setting of heart transplantation (HTX) is extremely rare. Herein, we report a case of combined HTX and proximal arch replacement at our institution.

## KEYWORDS

aortic arch, aortic surgery, atheromatosis, heart transplantation

## 1 | INTRODUCTION

Patients receiving orthotopic heart transplantation (HTX) due to ischemic cardiomyopathy (ICM) certainly present with an increased atherosclerotic profile. Occasionally extensive calcification of the ascending aorta is observed in these patients, in which concomitant replacement of the proximal aortic arch represents a valid option for these patients. Herein, we report a case of combined HTX and proximal arch replacement at our institution.

## 2 | CASE REPORT

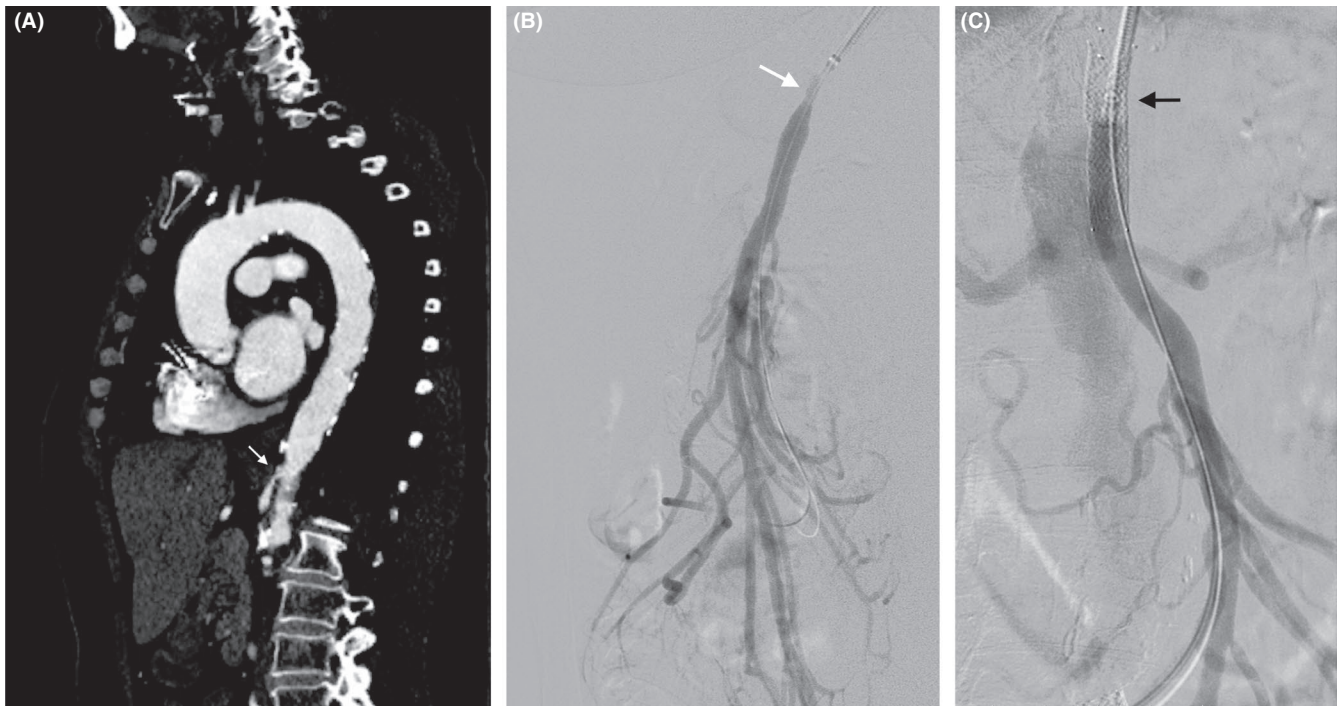
### 2.1 | Medical history

A female patient at 67 years of age and past history of ICM and implantation of implantable cardioverter-defibrillator

(ICD) due to recurrent, nonsustained ventricular tachycardia had previously undergone multiple coronary interventions but remained in chronic heart failure (New York Heart Association class III) with severely impaired global left ventricular (LV) function (ejection fraction; EF 20%). Along with the onsite multidisciplinary conference, it was decided to evaluate her for HTX/ LV assist device (LVAD). In the screening examinations, however, a relevant stenosis of the superior mesenteric artery (SMA) was found. Thus, percutaneous transluminal angioplasty (PTA) was successfully performed at proximal SMA (Figure 1). Moreover, diffusely scattered atheromatous plaques were also detected in the ascending aorta upon computed tomography scan, representing a prohibitive risk for conventional aortic clamping (Figure 2 and Appendix S1). Meanwhile, 5 months after PTA of the SMA and after 502 days on the waiting list an ABO blood group compatible and size-matched donor heart was offered and accepted for her.

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**FIGURE 1** Significant stenosis of the superior mesenteric artery (SMA) and percutaneous transluminal angioplasty (PTA). (A) Preoperative contrast-enhanced computed tomography (sagittal view) shows the diffuse calcification of the entire aorta with relevant stenosis of SMA (white arrow). (B) Preinterventional angiography of SMA showed the downstream branches and the proximal stenosis of SMA (white arrow). (C) Postinterventional angiography of SMA with a stent (black arrow)



**FIGURE 2** Preoperative chest computed tomography shows the presence of diffuse soft and hard atheromatous plaques at the level of the ascending aorta permitting no safe clamping zone. Plaques of ascendens aorta (A), and the aortic arch (B) (white arrow) are demonstrated in axial view. 3D reconstruction of the aorta shows remarkable irregular wall contour as a further expression of the atheroma burden (C)

## 2.2 | Surgery

Key steps of the surgical procedure are demonstrated in an online supplemental video (Video S1). In brief, after cardiopulmonary bypass (CPB) was conducted via the right axillary artery and right femoral vein, full sternotomy was performed. At 28°C, core body temperature hypothermic circulatory arrest (HCA) was achieved. After longitudinal aortotomy, the aorta was resected up to the brachiocephalic trunk. A significant change of aortic wall with wall thickening and fragile intimal plaque formation was evident. Antegrade brain perfusion via a selective cannula inserted in the left common

carotid artery was installed. The brain perfusion via right axillary artery was also maintained with clamping of brachiocephalic trunk. The aorta revealed diffuse aortic atheromatosis (Figure 3). Then, in an end-to-end manner, open anastomosis of a 26-mm vascular prosthesis (Uni-graft, Braun, Melsungen AG) to the proximal aortic arch was performed using cuffed anastomosis technique, and systemic perfusion was recommenced after 21 minutes of HCA and following deairing with aortic clamping placed on the vascular prosthesis. While awaiting donor organ arrival, rewarming of the recipient to 34°C target temperature was started. After the arrival of the donor organ, HTX was performed using the bicaval

technique. First, anastomosis of the left atria was performed using continuous sutures. Second, anastomosis of the lower followed by the upper vena cava was anastomosed. Finally, following the pulmonary artery's anastomosis, donor aorta was anastomosed with the proximal end of the vascular prosthesis (Figure 4). Cold and warm ischemic time for the donor heart were 143 and 62 minutes, respectively. The uncomplicated weaning from CPB was achieved with proper biventricular function under moderate catecholamine and adequate gas exchange function. Total CPB time was 244 minutes. The total operation time was 361 minutes including reperfusion of the transplanted heart over 119 minutes.

### 2.3 | Postoperative course

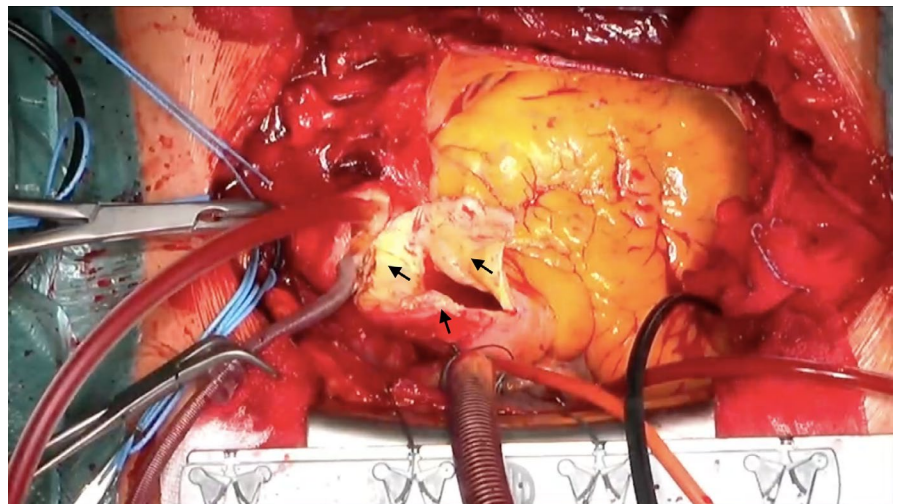
On the 1st postoperative day (POD), the patient had a complex focal epilepsy episode. Brain CT showed no cerebral infarction but a small left parietal subdural hematoma that required no further therapy. After that, postoperative course

was unproblematic. The patient was discharged from hospital on the 49th POD in a good condition. She subsequently passed 4 weeks of rehabilitation training and returned home without any need for further medical treatment beyond the regular therapy after HTX. Her neurological status is now unremarkable.

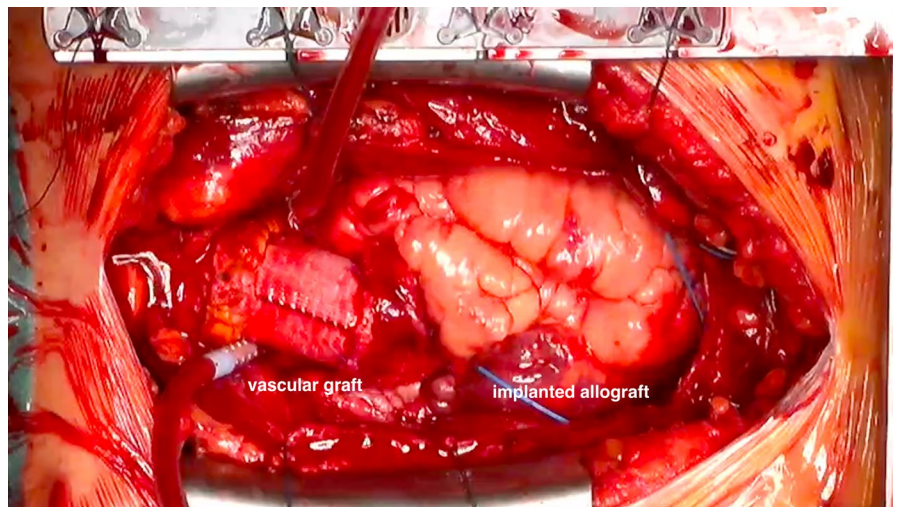
## 3 | DISCUSSION

The objective of this paper is to share our experience with combined HTX and aortic surgery for a specific indication of extended aortic calcification in patients awaiting HTX.

Comparing previously published cases of combined HTX and aortic surgery excluding congenital diseases,<sup>1-8</sup> the background of this patient differs substantially. The aortic pathology of all previous patients was aneurysmal degeneration. However, regarding our case, the patient had no aneurysm but significant calcification representing a contraindication for aortic cross-clamping. Thus, we performed combined



**FIGURE 3** Intraoperative finding of diffuse aortic atheromatosis (black arrows)



**FIGURE 4** Intraoperative findings from completed orthotopic heart transplantation and proximal aortic arch replacement



HTX and proximal aortic arch replacement to allow for a safe aortic clamping of the de novo implanted vascular graft with consecutive HTX performed in a regular fashion. Our patient experienced a relatively normal postoperative course. In our opinion, concomitant aortic surgery in the setting of HTX could be performable.

As far as the operative technique, in two previous reports, donor ascending aorta was used instead of the vascular graft for ascending aorta replacement.<sup>1,7</sup> Two patients underwent at first HTX followed by aortic surgery,<sup>1,4</sup> probably due to expected prolonged allograft ischemia. In our report, we performed at first ascending aorta replacement, so that the beginning of recipient operation was timely managed considering the transportation time of the donor organ. CPB was initiated by arterial axillary cannulation and femoral venous cannulation to allow immediate cooling of the patient prior to sternotomy, so that after preparation of the aorta and the right atrium, HCA at 28°C and aortic arch surgery with open anastomosis became possible before the arrival of a donor organ. In fact, after completion of arch anastomosis, CPB and rewarming were initiated, allowing yet a timely completion of preparation work to allow an adequate total ischemia time.

## 4 | CONCLUSION

With increasing numbers of elderly heart failure patients eligible for HTX but with significant aortic pathology, a concomitant aortic surgery strategy without aortic cross-clamping seems to be a feasible approach to enable HTX without highly increased risk of preoperative thromboembolic events.

## ACKNOWLEDGMENTS

Published with written consent of the patient.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest associated with this manuscript.

## AUTHOR CONTRIBUTIONS

Yukiharu Sugimura and Payam Akhyari: designed research/study. Yukiharu Sugimura: drafted the manuscript. Arash Mehdiani, Shintaro Katahira, Christina Loberg, Hug Aubin, Artur Lichtenberg, Udo Boeken, and Payam Akhyari: critically revised the manuscript. Christina Loberg, Artur Lichtenberg, Udo Boeken, and Payam Akhyari: took the responsibility for treatment decisions. Artur Lichtenberg, Udo Boeken, and Payam Akhyari: supervision the study.

## ETHICAL APPROVAL

This manuscript followed the principles of the Declaration of Helsinki and the Declaration of Istanbul. The appropriate

informed consent was obtained for the publication of this manuscript.

## DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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