Case Reports

Unplanned Autotransplantation for Complex Multi-Valve Replacement in a Super Morbid Obese Female: The Challenge of Intraoperative Decision Making

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Abstract: Cardiac autotransplantation is a rare technique typically reserved for the treatment of malignant tumors of the left atrium and left ventricle. Even when well planned, it conveys a high risk to the patient. This report discusses the intraoperative progression to an unplanned autotransplant for mitral valve repair while considering some decision making processes that cardiac surgeons make. Keywords: mitral valve surgery, transplantation, cardiac surgery. J Extra Corpor Technol. 2018;50:248–51

OVERVIEW

Although cardiac autotransplantation was first reported for the treatment of Prinzmetal’s angina (1), the technique is more commonly associated with the planned treatment of malignant tumors of the left atrium and left ventricle (LV) (2). Few reports describe cardiac autotransplantation for other types of cardiac surgeries (3,4). Arguably, most cardiac surgeons will never have performed this technique or considered it as a reasonable option to expose and repair the mitral valve (MV) when access is suboptimal or totally obscured. This case report describes the unplanned use of cardiac autotransplantation for MV replacement in a super morbid obese female and briefly discusses the intraoperative decision making processes a surgeon must go through when faced with rare or unseen events.

DESCRIPTION

A 63-year-old female was admitted to the emergency department of a non-cardiac regional hospital following a fall and injury to the right knee. At presentation, she was hypotensive (systolic blood pressure 55 mmHg) and diaphoretic, with biochemical evidence of hepatic and renal dysfunction. The patient reported a 6 month history of non-specific unwellness, before acutely deteriorating 3 days before presentation. The patient denied any chest pain, syncope, or dyspnoea, and diagnosis of an underlying cause was complicated by super morbid obesity status (body mass index 55). Additional relevant medical history included: type 2 diabetes, hypertension, anemia, Hodgkins lymphoma (resolved), and previous cardiac surgery involving mechanical aortic valve replacement and aortic root endartarectomy 3 years prior.

There was no obvious source for septic shock on computed tomography imaging. A transesophageal echo (TOE) revealed a $2.5 \times 2.5 \times 1.5$ cm vegetation on the posterior MV leaflet (Figure 1) combined with leaflet perforation and severe mitral obstruction. The vegetation appeared multilobar and complex, suggesting a high possibility of embolization. Mitral valve area was 1.1 cm$^2$. The
mechanical aortic valve (a 21-mm Carbomedics Top Hat® Supra-Annular Aortic Valve; Carbomedics, Austin, TX) appeared to be functioning normally. Left ventricular end diastolic volume was 71.3 mL, left ventricular end systolic volume 22.4 mL, and left ventricular ejection fraction was 69%.

Broad-spectrum intravenous antibiotics were commenced (piperacillin/tazobactam and vancomycin) and later descaled to benzylpenicillin following positive blood cultures for streptococci. The circulation was supported with vasoactive agents to target a mean arterial pressure $\geq 65$ mmHg.

The patient was air transferred to a tertiary level cardiothoracic hospital for consideration of surgical mitral valve replacement (MVR). Despite ongoing sepsis and considerable comorbidities, the surgical team felt that replacement of the MV was appropriate and achievable and the patient was prepared for urgent MVR. Premedication was 300 mg ranitidine and 10 mg temazepam.

**SURGICAL MANAGEMENT**

Anesthetic induction was uneventful and achieved with midazolam (5 mg), fentanyl (250 mcg), and rocuronium (100 mg). As well as standard lines, a Swan–Ganz catheter was also placed. The initial plan was to place the patient onto peripheral cardiopulmonary bypass (CPB) to both reduce the risk of resternotomy and to declutter the surgical field. The right femoral vessels were exposed and wire placement confirmed on TOE. However, attempted cannulation of the femoral artery resulted in vessel injury and this was abandoned. The decision was made to proceed to sternotomy off CPB and to place CPB cannulae centrally. A sternotomy was performed and dense adhesions around the inferior vena cava, superior vena cava, aorta, and pulmonary artery were divided. The heart was deep set within the chest cavity. The aorta was small and short but cannulated proximally with a 22Fr RMI cannula (Edwards Lifesciences LLC, Irvine, CA). CPB was commenced using Medtronic Affinity NT (Medtronic Inc., Minneapolis, MN), X-coated circuit (Terumo Cardiovascular Systems Corp, Ann Arbor, MI) and blood prime. After achieving full bypass, the aorta was clamped and antegrade/retrograde crystalloid cardioplegia given to achieve myocardial arrest. Twenty-four minutes into CPB, the aortic cannula was accidently displaced, followed by 150 seconds of circulatory arrest while re-inserting the cannula in the aorta at 35°C. Although there was minimal blood loss during this emergent situation, a cell-saver was used to avoid red cell loss. The patient was cooled to 28°C and a right to left atriotomy performed to expose the MV. In addition to the vegetation on the posterior leaflet of the MV (Figure 1), an atrioventricular abscess was noted, as well as extensive mitral-annular and aortic root calcification. The decision was made to remove the mechanical aortic valve to improve access to the MV and atrioventricular region. Complete debridement and patching of the atrioventricular component was attempted. Despite successful removal of the aortic valve, the surgeon was not confident that the view for

Figure 1. (A) 3-D image of MV showing vegetation on posterior leaflet and (B) 2-D image of vegetation traversing through MV LV.
atrioventricular patching was adequate. Approximately 4 hours 30 minutes into the operation, the decision was made to perform an autotransplant. In view of a short superior right atrial and superior vena cava cuff and a non-mobilized posterior portion of the aorta, the decision was made to cool to 25°C in anticipation of circulatory arrest to allow for arterial and venous cannula removal during repair.

Following cardioplegia, cardiectomy was carried out by serial transections of the superior vena cava, inferior vena cava, aorta, and pulmonary artery. Once explanted, the MV annulus and aorto-mitral curtain was reconstructed in the area of the abscess with double layered porcine pericardium, of which the posterior portion became the anterior mitral annulus and the anterior portion became the posterior aspect of the aortic root replacement. A mechanical MV was sewn-in with individual sutures. A 19-mm mechanical aortic valve and a 22-mm Gelweave graft were sewn together into the aortic annulus (Figure 2). The right coronary ostia was heavily calcified and deemed unsewable. A single length of saphenous vein graft (SVG) was harvested from the right leg and anastomosed to the right coronary artery. The right atrial cuff and coronary sinus required patching with bovine pericardium. Similarly, the left atrial cuff was also augmented with bovine pericardium. The heart was then reimplanted using 4-0 prolene for the pulmonary artery. The proximal aortic anastomosis and SVG to native aorta was performed under circulatory arrest (20 minutes at 25°C). The patient was slowly rewarmed to 36.8°C and the heart rested on CPB for an extended period because of the long ischemic time of 297 minutes. Total CPB time was 479 minutes. Atrial and ventricular pacing wires were attached and the patient weaned off bypass on moderate inotropic support. Considering the difficulty accessing the femoral vessels, the decision was made not to place an intra aortic balloon pump. Packed red blood cells (PRBC) were transfused to maintain a hemoglobin level of 80 g/L. post pump and rotational thromboelastometry (ROTEM®, Tem Innovations GmbH, Basel, Switzerland) was used to guide further blood products to achieve hemostasis. In total, 29 units of PRBC, 4× prothrombinex, 4× platelets, 4× fresh frozen plasma, 15× cryoprecipitate and factor VIIa were given during intra- and post-operative care. The sternum was left open post-CPB and patient transferred to intensive care, haemodynamically stable with a systolic BP 85 mmHg on moderate doses of inotropes.

**POST OPERATIVE INTENSIVE CARE MANAGEMENT**

The patient survived the first few days and then made slow but steady progress. Renal replacement therapy was required, but inotrope infusions were reduced. The chest was closed, and a permanent pacemaker was inserted on day 5. Unfortunately her recovery course was complicated by a right groin wound infection with cultures growing streptococcus mitis. The patient became septic despite treatment with appropriate antimicrobials. A tracheostomy was performed on post-operative day 9. However, there was progressive worsening of the shock state and multiple organ failure in the setting of uncontrolled sepsis. Cardiorespiratory support was discontinued and comfort-oriented care was commenced after discussion with family.

**COMMENT**

First reported by Cooley in 1985 (5), cardiac autotransplantation is most commonly associated with treating primary cardiac tumors (5–8). The largest case series of 35 cardiac autotransplants suggests a high operative mortality associated with this procedure of up to 43% even when planned (7). However, there are only two reports in the literature of cardiac autotransplantation being used as a last resort option for the replacement of the MV when standard surgical access is suboptimal or non-existent (4,9). Novitzky et al. performed a successful autotransplant for MV replacement after visualization of the MV annulus became impossible. Concerned that suboptimal access to the MV may be under-reported, the authors followed up their procedure with a survey sent to 3,000 surgeons. Of the 1,120 respondents, 70% indicated they had encountered difficulty in obtaining access to and exposure of the MV,
Cardiac surgeons plan a surgical procedure by having a good understanding of the pre-operative comorbidities, strategising a range of possible difficulties and complications they may encounter. Given the limited case reports and collegiate discussion on this rare scenario, the option to progress to unplanned autotransplantation peri-procedure is one that few surgeons would normally consider. The complexity of peri-procedure decision making during high-risk cardiac surgery has not adequately been described in the literature, yet it should be viewed as a valuable additional “non-technical” skill (10). Decision-making processes have been incorporated into the training programs of other vocations, such as pilots (11), yet it is currently not recognized as a teachable skill in junior surgical training programs.

Some have suggested that the decision-making model adopted by pilots would be appropriate for surgery. These models are based on 1) problem detection, 2) situation assessment (based on estimation of risk vs. time), and 3) choice of action (12). An alternative (yet linked) approach suggests that during situations of high uncertainty, inadequate information, shifting goals, high time pressures, and high risk, a “naturalistic” decision-making strategy may also be beneficial. The “naturalistic” approach can be broken up into four main strategies: intuitive; rule based; option comparison, and creative (13).

When approaching a planned cardiac transplant (auto- or orthotopic), cannulation techniques take into consideration planned explantation and implantation of the heart. The situation facing the surgical team in this present case report was unplanned and one that is rarely encountered in a surgical career. The decision-making algorithm used by the highly experienced “transplant” surgeon possibly fits into the creative decision making category of the “naturalistic” strategies. The fact that the surgeon involved in this report had cardiac transplant experience probably allowed for the decision-making process to be dynamic, switching between intuition and rule-based algorithms (pattern based) and applying the creative aspects to the surgical procedure.

Despite an unsuccessful outcome in this instance, this complex surgery produced a technically successful operation and promising initial post-operative recovery. The decision to perform an autotransplant peri-procedure was made by not only accepting the (exceedingly) high risk to the patient (situational risk assessment), but also by acknowledging that there were limited alternative options. There was also a reasonable expectation of a successful outcome (managing risk tolerance). At the local level, we have learned that early consideration of cardiac autotransplantation and earlier implementation in the course of the procedure may be more likely associated with survival. More widely, this case report demonstrates the value of appropriate decision-making in high-risk environments and why non-technical skills should also be developed in junior surgical trainees.

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REFERENCES