Right Anterior Minithoracotomy for Redo Aortic Valve Replacement After Coronary Artery Bypass Grafting with Bilateral Internal Thoracic Artery: a Case Report

Hironobu Nishiori[1], Tomoki Sakata[1], and Goro Matsumiya[1]

[1]Chiba Daigaku Igakubu Fuzoku Byoin

October 5, 2022

Abstract

A 63-year-old male, with a history of coronary artery bypass grafting using bilateral internal thoracic artery grafts, underwent surgical aortic valve replacement. Avoiding the graft injury, we selected the right anterior mini-thoracotomy approach under cardiac arrest with systemic hyperkalemia with remaining bilateral internal thoracic artery grafts open. Deep hypothermia was induced to obtain more reliable myocardial protection. We believe this strategy can be considered as a therapeutic option in patients requiring aortic valve replacement but unsuitable for transcatheter aortic valve replacement.

Introduction

The operative risk of aortic valve replacement (AVR) after coronary artery bypass grafting (CABG) is known to be high because graft may be injured by median sternotomy, leading to serious myocardial ischemia and resultant poor prognosis.[1] Moreover, in some cases, trans-catheter aortic valve replacement (TAVR) after CABG can not be selected for various reasons, and surgical AVR must be performed.[2] In such situations, myocardial protection during cardiac surgery is an important point of discussion, and some unique methods have been reported to avoid graft damage.[3] We experienced a case of AVR through right lateral mini-thoracotomy after CABG with the bilateral internal thoracic artery (ITA) grafts. As the grafts were patent and native coronary arteries were totally occluded, systemic hyperkalemia and deep hypothermia were utilized to induce cardiac arrest and maintain adequate myocardial protection without touching the bilateral ITA grafts. Herein is reported the methods and cautions in this strategy. We have obtained the consent of the patient for publication.

Case Description

A 63-year-old man, who underwent CABG 10 years ago, was admitted to our hospital with chief complaints of dyspnea and chest pain. The transthoracic echocardiography showed aortic valve area of 0.66 cm2, transvalvular peak velocity of 3.4 m/sec, mean transvalvular pressure gradient of 28 mmHg, and left ventricular ejection fraction of 44%, and he was diagnosed as severe aortic valve stenosis. In the previous CABG, the right and left ITAs were anastomosed to the anterior descending artery diagonal artery, respectively. The radial artery was utilized as Y-graft and anastomosed to the posterior lateral and descending branches sequentially. The computed tomography imaging revealed that right ITA crossed over the ascending aorta (Fig.1). The right ITA appeared to be heavily adherent to the sternum (Fig.2). The coronary angiography showed the native left and right coronary arteries were all occluded proximally while all grafts were patent. Moreover, the right ventricular branches were not visualized even from the graft (Fig. 3A, 3B). We decided to do surgical AVR with right anterior thoracotomy. TAVR was not selected since the patient was young enough and had a long life expectancy, surgical AVR seemed appropriate considering the durability of the prosthetic valve.

A 7-cm skin incision was placed at the third right intercostal space, and the ascending aorta was exposed. The cardiopulmonary bypass (CPB) was established between the right axillary artery and the right femoral vein. The bilateral ITA grafts were neither touched nor clamped. After ventricular fibrillation induced by systemic cooling, the aorta was cross clamped. Potassium was administered at the dose of 40 mEq via the CPB. The potassium level elevated to 8.7 mEq/dL and cardiac arrest was obtained. We maintained the patient's body temperature deep enough at 19 degrees Celsius. Additional 40 mEq potassium was administered twice, targeting potassium level 7.0 to 8.0 mEq/dL. A 21 mm Magna Ease (Edwards Lifescience Corporation, Irvine, CA, USA) was implanted. The potassium level was normalized with administration of glucose and insulin and extracorporeal ultrafiltation method during CPB. After rewarming, the aorta was de-clamped. The CPB was successfully weaned off. The postoperative course was uneventful and the patient was discharged on the postoperative Day 18 after rehabilitation. Two years after the operation, follow-up transthoracic echocardiography showed an improved ejection fraction of 54%, and no para-valvular leakage.

Comment

The number of patients who require aortic valve replacement (AVR) for severe aortic stenosis (AS) has been increasing.[1] When performing re-do AVR after CABG, clamping bypass grafts through median sternotomy used to be performed for sufficient myocardial protection. However, this measure imposes high risk due to severe adhesion of the patent grafts, and graft injury occurs in 5 to 50% of cases, which leads to a poor prognosis.[2,4] This makes redo-AVR challenging, with a surgical mortality rate of 6-16%.[2,5] Kaneko et al.[3] introduced the right intercostal approach for re-do AVR after CABG with the patent left ITA. Cardioplegia was not used to avoid incomplete cardiac arrest due to washout from patent ITAs. The blood supply was completely graft-dependent and the native coronary arteries were totally occluded, therefore, it was theoretically possible to operate under beating condition. However, considering the impaired ejection fraction due to coronary arterial disease, cardiac arrest was chosen, which provides more reliable myocardial protection. In addition, as the right ventricular branch was not adequately contrasted in the preoperative coronary angiography, deep hypothermia was induced at 19°C to minimize myocardial oxygen consumption in case of poor right ventricular perfusion. Deep hypothermia at 19 °C can achieve reduced myocardial oxygen consumption by 45% compared to at 28°C.[7]

TAVR might be an alternative option in patients with a history of CABG. However, the long-term results and the durability of the valve remains unclear. Surgical AVR is required after TAVR in some situations including structural valve degeneration, para-valvular leakage, and complications of TAVR. Fukuhara and his colleagues[2]reported that 1% of patients required TAVR explantation within eight years after TAVR, more than the number of patients who had redo TAVR. Therefore, we believe it is essential for surgeons to understand the strategy for surgical AVR as a therapeutic option in post CABG patients.

References

1. Byrne JG, Karavas AN, Filsoufi F, et al. Aortic valve surgery after previous coronary artery bypass grafting with functioning internal mammary artery grafts. Ann Thorac Surg. 2002;73:779–784.

2. Fukuhara S, Brescia AA, Shiomi S, et al. Surgical explantation of transcatheter aortic bioprostheses: Results and clinical implications. J Thorac Cardiovasc Surg. 2021;162(2):539-547.e1.

3. Kaneko T, Nauta F, Borstlap W, McGurk S, Rawn JD, Cohn LH. The "no-dissection" technique is safe for r eoperative aortic valve replacement with a patent left internal thoracic artery graft. J Thorac Cardiovasc Surg 2012;144:1036-1040.

4. Masaki N, Ogasawara T, Kawarai S, Matsuki K. Aortic valve replacement for patients with functioning internal mammalian artery grafts. Ann Thorac Cardiovasc Surg. 2018;24:103-105.

5. Nishi H, Mitsuno M, Yamamura M, et al. Safe approach for redo coronary artery bypass grafting-preventing injury to the patent graft to the left anterior descending artery. Ann Thorac Cardiovasc Surg. 2010;16:253-258.

6. Odell JA, Mullany CJ, Schaff HV, et al. Aortic valve replacement after previous coronary artery bypass grafting. Ann Thorac Surg 1996; 62: 1424-1430.

7. Rousou JH, Engelman RM, Dobbs WA, et al. The optimal potassium concentration in cardioplegic solutions. Ann Thorac Surg. 1981;32:75-79.

Figure legends

Fig. 1 Preoperative computed tomography image showing LITA and RITA runing just under the sternal midline and appear to be adherent to the sternum. (yellow arrows)

LITA: left internal thoracic artery RITA: right internal thoracic artery

Fig. 2 Preoperative computed tomography image showing that RITA run across the ascending aorta (arrow)

RITA: right internal thoracic artery

Fig. 3 Preoperative coronary angiography showing RITA anastomosed to LAD (A), LITA and RA were composed as Y-graft, with LITA anastomosed to Dx, and RA to PL and PD sequentially. The right ventricular branches are not adequately contrasted, which compromise the right ventricular myocardial perfusion if cardioplegia is used. (B)

Dx: diagonal branch LAD: left anterior descending LITA: left internal thoracic artery PD: posterior descending branch PD: posterior descending branch PL: posterior lateral RA: radial artery RITA: right internal thoracic artery