**Case
Report**

Aortic Valve Replacement for Patients with Functioning Internal Mammalian Artery Grafts

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Aortic valve replacement (AVR) for patients with functioning internal mammalian artery (ITA) grafts is technically challenging, and the optimal treatment strategy for these situations remains controversial. Here, we report five cases of AVR with ITA graft using continuous retrograde cardioplegia in addition to moderate hypothermia without the clamping of ITA and discuss the management of these cases.

Keywords: aortic valve replacement, internal mammalian artery, redo surgery

Introduction

Using the left internal thoracic artery (LITA) to bypass the left anterior descending coronary artery is standard in coronary artery bypass grafting (CABG). In an aging society, some patients having undergone CABG may need re-operative aortic valve replacement (AVR) due to aortic valve stenosis progression. The traditional strategy for these redo surgeries has been re-operative sternotomy with dissection and clamping of the LITA graft.¹⁾ However, these procedures carried a risk of injury to the LITA graft. LITA graft injury is associated with a poor prognosis²⁾ and redo AVR with a functioning LITA graft is technically challenging. Several reports have described other procedures not involving LITA graft dissection, such as deep hypothermia and hyperkalemia.^{3,4)} However, the optimal treatment for these situations remains controversial. We performed AVR on five patients without

dissecting or clamping the LITA grafts and used moderate hypothermia with intermittent selective antegrade cardioplegia and continuous retrograde cardioplegia, and hereby report our management of these cases.

Case Report

Baseline clinical characteristics are shown in **Table 1**. Ages ranged between 55 and 84 years; four patients (80%) were men. All patients had undergone CABG 36 to 113 months previously, with a mean of 2.2 ± 0.8 bypass grafts used. All patients had aortic valve stenosis. In one case, we performed an additional closure of an atrial septal defect. The surgical technique was as follows: first, we exteriorized the axillary artery or femoral artery as the arterial return for cardiopulmonary bypass (CPB) and anastomosed an 8-mm synthetic graft in an end-to-side fashion. We performed a median full sternotomy. We established CPB using bicaval drainage and axillary artery or femoral arterial return and started systemic cooling to a target rectal temperature of 28°C. We dissected the ascending aorta and aortic root to the maximum extent. The LITA grafts were kept untouched and undissected. A venting tube was inserted from the right upper pulmonary vein to the left ventricle. Cannulas for antegrade and retrograde cardioplegia were placed on the aortic root and the coronary sinus via the right atrium, respectively. The ascending aorta was clamped and cardiac arrest was achieved by antegrade cardioplegia.

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Table 1 Patient summary

Case	Age (y)	Sex	Diagnosis	CABG	Interval time (months)	Approach	CP	Procedure	Valve	Arrest/ VF	CPB (min)	ACC (min)	RT (°C)	K ⁺ (mEq/l)	Intubation (days)	ICU stay (days)	Hospital stay (days)	Complication
1	82	M	AS	LITA-LAD, SVG-LCx, SVG-RCA	113	Median	Ante + retro	AVR	CEP magna 19	Arrest	333	104	27.1	4.4–5.5	10	14	46	Lung hemorrhage
2	84	M	AS	LITA-LAD	37	Median	Ante + retro	AVR	CEP magna 21	Arrest	259	109	28.5	5.5–5.9	5	8	41	Long intubation
3	73	F	AS	LITA-LAD, SVG-RCA	36	Median	Ante + retro	AVR	SJM Regent17	Arrest	161	105	26.7	5.0–5.9	4	8	50	MRSA enteritis
4	55	M	AS, Low EF, ASD	LITA-LAD, SVG-LCx-RCA	97	Median	Ante + retro	AVR, ASD closure	SJM Regent21	VF	332	156	27.3	4.3–6.2	3	6	28	Cerebral infarction
5	74	M	AS	LITA-LAD, SVG-LCx	55	Median	Ante + retro	AVR	SJM Regent19	VF	207	126	28.5	4.7–6.3	1	2	27	None

AS: aortic valve stenosis; EF: ejection fraction; ASD: atrial septal defect; CABG: coronary artery bypass grafting; LITA: left internal thoracic artery; LAD: left anterior descending coronary artery; SVG: saphenous vein graft; LCx: left circumflex coronary artery; RCA: right coronary artery; CP: cardioplegia; AVR: aortic valve replacement; VF: ventricular fibrillation; CPB: cardiopulmonary bypass; ACC: aortic cross clamp; RT: rectal temperature; K⁺: serum potassium; ICU: intensive care unit

Fig. 1 Left ventricular ejection fraction (LVEF) on ultrasound echocardiographic examination (UCG) in all cases at the preoperation, predischage, and long term after the operation (between 16 and 99 months). LVEF was maintained after the procedure.

Continuous retrograde cardioplegia was maintained with a perfusion pressure of 50 mm Hg, with antegrade selective cardioplegia every 30 minutes using a cold blood cardioplegic solution for myocardial protection. The heart rhythms were intermittently ventricular fibrillation during the operation in two patients. In addition, serum potassium levels were controlled between 4.4 and 6.3 mEq/L during the aorta cross clamping periods. The aorta was incised transversely, and AVR was performed using mechanical or bioprosthetic valves. The prosthesis was placed at the supra-annular position. Terminal warm cardioplegic solution was injected via the aortic root cannula after closing the aortotomy, and the ascending aorta was subsequently de-clamped.

Two patients developed ventricular fibrillation and were managed by defibrillation. The weaning of CPB was uneventful in all cases. Mean CPB time was 259 ± 76 minutes, and clamp time was 120 ± 22 minutes. Perioperative myocardial infarction did not occur. Echocardiographic exams at predischage and long term after the operation (over 12 months; 16–99 months) showed acceptable left ventricular function in all cases (**Fig. 1**).

Discussion

Redo cardiac surgery after CABG carries a high risk of postoperative complications and operative death. The operative mortality rate associated with redo AVR after CABG is reportedly 6%–16%, making this procedure a challenge even with modern techniques and facilities.^{3,5)}

It has been reported that internal mammalian artery (ITA) grafts should be dissected and clamped during AVR for myocardial protection. However, this was associated with graft injury in 5%–50% of cases, and consequently, poor prognosis.^{2,4,6)} Our report indicates that moderate hypothermia, intermittent antegrade cardioplegia, and continuous retrograde cardioplegia can lead to favorable early outcomes after redo AVR in patients with active ITA bypass grafts. Our report has also demonstrated that left ventricular function can be maintained until long after the procedure.

Previous reports have introduced several approaches to avoid dissecting the LITA graft, the most basic of which was deep hypothermia to approximately 20°C.³⁾ Myocardial protection with hyperkalemia (6–7 mEq/L) during CPB and beating heart under normothermic conditions with continuous retrograde coronary sinus perfusion of oxygenated blood have also been reported with good outcomes.^{3,4,7)} However, almost all these reports had small sample sizes, and the optimal surgical management remains unclear, warranting further investigation.

Patients most likely to need redo AVRs would be elderly with several preoperative risk factors. In the future, more minimally invasive surgical techniques will have hopefully been established like transcatheter AVR. For other patients not suited for this procedure, our strategy of moderate hypothermia, intermittent antegrade cardioplegia, and continuous retrograde cardioplegia without touching the ITA graft could be therapeutic options.

Conclusion

We reported the case series of redo AVR for patients with functioning LITA graft. The strategy of untouched ITA graft using moderate hypothermia with intermittent selective antegrade cardioplegia and continuous retrograde cardioplegia would be one of the optimal treatment options in these cases.

Disclosure Statement

The authors have no conflicts of interest to declare.

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