

# Minimally Invasive Direct Redo Coronary Artery Bypass Grafting

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**Redo coronary artery bypass grafting due to graft failure and the progression of new lesions has been increasing in frequency recently. We are often forced to revascularize only the left anterior descending artery (LAD) in very elderly patients with a high risk to median sternotomy. We performed reoperative minimally invasive direct coronary artery bypass grafting (MIDCABG) in seven patients. The target sites were as follows: LAD, 7; first diagonal branch, 1; and the graft material was the left internal thoracic artery (LITA), 7; and saphenous vein graft (SVG), 1. Complete revascularization was accomplished in all patients, by including hybrid therapy in three patients and axillo-coronary bypass grafting with SVGs in two patients. Postoperative angiography showed all patent grafts and all patients were discharged. During a mean follow-up period of 2.4 years (range: 0.5 to 3.5 years), all were free from cardiac events, except for one patient who had recurrent angina due to failure of a previously patent graft 3 years after redo MIDCAB.**

**These results suggest that MIDCABG via left antero-lateral thoracotomy is an effective and safe technique in redo cases, as well as an alternative procedure for hybrid revascularization that combines minimally invasive revascularization of LAD with additional catheter interventional therapy. (Ann Thorac Cardiovasc Surg 2002; 8: 209–12)**

**Key words:** minimally invasive direct coronary artery bypass grafting (MIDCABG), redo cases, hybrid therapy, axillo-coronary bypass grafting

## Introduction

Redo coronary artery bypass grafting (CABG) due to graft failure and the progression of new lesions has been increasing in frequency recently. In particular, the more high risk conditions a patient has, the more significant off-pump CABG becomes. Complete revascularization for multiple vessel disease has become feasible by off-pump CABG accessed through median sternotomy. Instrument im-

provements (such as stabilizers and shunt tubes), as well as the accumulation of surgical and anesthetic experience have done a great deal to improve clinical results. When clinicians must balance quality of life considerations in very elderly patients along with high risks procedures such as redos, there is competition between minimally invasive direct coronary artery bypass grafting (MIDCABG) and the use of a new device as rotablator for diffuse calcified lesions just proximal to the left anterior descending artery (LAD). Furthermore, we are often forced to revascularize only the LADs in very elderly patients carrying high risks for median sternotomy. Hybrid therapy combining surgical revascularization of the LAD with interventional procedures for additional coronary lesions is considered to be an attractive alternative method.

In this report, we describe seven patients undergoing reoperative MIDCABGs and evaluate the effectiveness of the procedure.

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**Table 1. Preoperative characteristics**

Case	Age (y)	Sex	Previous procedure	Interval (y)	HL	HT	Smoking	DM	CRF	CVA	MI	EF (%)	Hybrid
1	69	F	SVG-LCX-P SVG-LAD-O	20	+	-	+	-	-	-	-	46	+
2	67	M	SVG-LCX-P SVG-LAD-S	15	+	+	-	-	+	-	+	53	+
3	70	M	SVG-D1-P SVG-LAD-S	8.6	+	-	+	-	-	-	+	59	-
4	53	M	SVG-LCX-P SVG-RCA-P SVG-LAD-O	10	+	+	+	+	-	-	-	50	-
5	70	M	SVG-LCX-O SVG-RCA-O SVG-LAD-S	9.5	+	+	+	-	+	+	-	56	+
6	73	F	SVG-LAD-O	21	-	-	-	-	-	-	+	49	-
7	80	F	Post MVR SVG-RCA-P SVG-LCX-P	4	-	+	-	-	-	-	-	53	-

F, female; M, male; SVG, saphenous vein graft; LCX, coronary artery of left circumflex territory; LAD, left anterior descending coronary artery; D1, diagonal branch 1; RCA, right coronary artery; O, occluded; P, patent; S, stenotic; HL, hyperlipidemia; HT, hypertension; DM, diabetes mellitus; CRF, chronic renal failure; CVA, cerebral vascular accident; MI, myocardial infarction; EF, ejection fraction of left ventricle; Hybrid, hybrid procedure

## Patients and Methods

Between October 1996 and October 2001, we performed 58 primary MIDCABGs. During the same time period, seven patients underwent redo MIDCABGs, involving 4 men and 3 women with a mean age of 68.9 years (range: 53 to 80 years). The causes of reoperation were graft failure in six patients and progression of a new lesion in one patient. The mean interval between the first operation and the reoperation was 12.6 years (range: 4 to 21 years). The target sites were LAD, 7; and first diagonal branch, 1; graft material was left in the internal thoracic artery (LITA), 7; and saphenous vein graft (SVG), 1. The left internal thoracic artery (LITA) was anastomosed to the LAD in five patients. Axillo-coronary bypass grafting was performed in an 80-year-old woman, in whom progression of her LAD lesion had occurred 4 years after combined mitral valve replacement and double-CABG (SVG to right coronary artery, SVG to left circumflex artery) and whose preoperative angiography showed a stenotic LITA. Combined axillo-coronary bypass grafting by SVG to the first diagonal branch and a MIDCABG by LITA to the LAD were performed in a 73-year-old woman, who had recurrent angina 21 years after CABG. Complete revascularization was accomplished in all patients, including 3 on hybrid therapy.

When selecting hybrid therapy, interventions were performed on stenotic lesions (except those in the LADs) before redo-MIDCABG. The major preoperative risk factors were as follows: hyperlipidemia in five patients, smoking in four patients, diabetes in one patient, chronic renal failure in two patients, a cerebral vascular accident in one patient, and previous myocardial infarctions in three patients. The patients' left ventricular ejection fractions ranged from 0.46 to 0.59 (mean: 0.52) (Table 1).

The univent endotracheal tube is introduced for providing one-lung ventilation during the operation. The submammary skin incision was made, about 8 cm in length. The fourth intercostal space was exposed, and the left internal thoracic artery was harvested in a semi-skeletonization under direct vision (without the use of special retractors and/or video-assisted thoracoscopy). The LAD and target vessels were easily identified via the presence of old grafts. To control coronary flow, elastic looping sutures were placed at the proximal and distal sites of anastomosis. We did not reduce the heart rate or perform the preconditioning for coronary ischemia. After heparinization, the LITA was anastomosed to the target vessel using the double parachute technique with 8-0 polypropylene sutures. The intraluminal shunt and compression type stabilizer were used during the anastomosis. The chest was closed in layers, leaving a drainage tube. Con-

**Table 2. Postoperative characteristics**

Case	Procedure	Ope time (hrs)	PMI	IABP	Complication	Graft	Result
1	LITA-LAD	2.8	–	–	Wound detachment	Patent	Alive
2	LITA-LAD	2.6	–	+	–	Patent	Alive
3	LITA-LAD	3.3	–	–	–	Patent	Alive
4	LITA-LAD	3.5	–	–	–	Patent	Alive
5	LITA-LAD	2.7	–	–	–	Patent	Alive
6	LITA-LAD, SVG-D1*	4.5	–	–	–	Patent	Alive
7	SVG-LAD*	3.5	–	+	–	Patent	Alive

LITA, left internal thoracic artery; LAD, left anterior descending coronary artery;  
 SVG, saphenous vein graft; D1, diagonal branch 1; PMI, postoperative myocardial infarction;  
 IABP, intra-aortic ballon pumping; \*, from axillary artery

tinuous administration of heparin was initiated a few hours after operation and, afterwards, oral administration of aspirin was given.

## Results

The mean operative time was 3.4 hours (range: 2.6 to 4.5 hours). Intra-aortic balloon pumping was performed in two patients during the perioperative period. Postoperative myocardial infarction did not occur in any of the patients, while a wound infection occurred in one patient as a postoperative complication. Postoperative angiography showed that all grafts were patent, and all patients were subsequently discharged. During a mean follow-up period of 2.4 years (range: 0.5 to 3.5 years), all of the study patients remained alive. There was one case of recurrent angina due to failure of a previously patent graft 3 years after redo MIDCABG. All others were free from cardiac events during the follow-up period (Table 2).

## Comment

Since the introduction of MIDCABG, the trend toward less invasive coronary artery surgery spread rapidly throughout the world.<sup>4,6)</sup> With the development of improved technology and improved anesthetic management, off-pump CABG via median sternotomy has replaced earlier procedures for the purpose of complete revascularization. However, MIDCABG via a small left anterolateral thoracotomy remains as an effective procedure as ever for patients with the following factors: 1) a culprit lesion just proximal to the LAD, which is calcified diffusely, 2) median sternotomy is anticipated to be dangerous, such as in reoperation cases, 3) the use of cardiopulmonary bypass is disadvantageous for multiple

comorbidities.<sup>10)</sup>

We performed redo-MIDCABGs as redo-CABGs in order to avoid embolization of patent but diseased vein grafts, catastrophic complications during re-exposure (such as laceration of the right ventricle and/or injury of patent grafts), the added risks that accompany elderly patients with multiple comorbidities, and so forth. This selection is supported by the fact that the operative mortality rate in off-pump redo-CABGs is relatively low compared to that in conventional on-pump redo-CABGs.<sup>1-3)</sup>

The hybrid procedure was accepted in three patients to accomplish complete revascularization because interventional therapy of the coronary lesions (except LAD) was likely to have a lower rate of restenosis than the LAD, especially just proximal LAD.<sup>8,9)</sup> In all hybrid cases, catheter interventional therapy was performed before the MIDCABs, although there was the advantage that it could increase coronary flow reserves, and the disadvantage that it could not be adapted for unstable angina and was sure to need subsequent pharmacological treatment.<sup>5,7)</sup> In this series, the operative mortality rate, postoperative neurologic deficit rate, and postoperative major complication rate were 0%.

The MIDCABG technique seems to be well-established from mid-term results.<sup>6)</sup> Even in redo cases, the LITA was easily harvested using semi-skeltonization by direct vision, without the use of special retractors and/or video-assisted thoracoscopy. A semi-skeltonized ITA without muscle harvested from the 2 intercostal space (ICS) to the 5ICS could reach any point required on the anterior vessels in our experience. Even if the LAD was in the muscle, it was feasible to identify it. We do not compromise with the anastomosis of segment 8 of LAD. To control coronary flow, elastic looping sutures were placed at the proximal and distal sites of anastomosis. But in post-

operative coronary angiography, no significant stenosis of the native coronary was recognized. The use of intraluminal shunting has enabled safe anastomosis without consideration of ischemic time. In redo cases, compression type stabilizers were used during the anastomosis. Furthermore, the adhesions of the pericardium are important in reducing the motion of heart – thereby acting as a natural stabilizer.

We selected minimally invasive axillary-coronary artery bypass grafting using vein grafts in two patients. This approach was thought to be an alternative for patients in whom the internal thoracic arteries were not applied in situ, though there was no data regarding long-term follow-up results for this procedure. And the radial artery graft may not be long enough to sufficiently reach from the axillary artery and coronary artery.

These results suggest that MIDCABG via left anterolateral thoracotomy is an effective and safe technique in redo cases. Furthermore, MIDCABG remains a viable alternative procedure for hybrid revascularization combined with minimally invasive revascularization of LAD with additional catheter interventional therapy.

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