Original Article

The Left Internal Thoracic Artery and Radial Artery Composite Graft in Off-pump Coronary Artery Bypass Grafting

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Arterial multivessel bypass grafting without extra corporeal circulation and manipulation of the ascending aorta should be a good surgical option for the treatment of coronary artery disease. An internal thoracic artery (ITA)-radial artery (RA) composite graft was used for this purpose. Between July 2000 and October 2001, we employed the LITA-RA composite graft for off-pump coronary artery bypass in 15 cases. Mean patient age was 71.3±5.8 years old. Left main trunk disease was present in six patients and triple-vessel disease in four patients. Preoperative concomitant disease was renal dysfunction in three cases, cerebrovascular disease in four and diabetes mellitus in five cases. Two patients had a so-called bad aorta. Twelve elective operations and three urgent operations were carried out for unstable angina. Two to four (mean 2.6±0.7) anastomoses were performed per patient. Complete revascularization was achieved in 12 out of 15 patients. Mean operating time was 335±53 min. Mean intraoperative blood loss was 595±375 ml and nine patients underwent the operation without blood transfusion. There was no PMI, no brain disorder, and no death. Postoperative coronary angiography in all patients documented a good patency rate (LITA 15/15, RA 21/21, right gastroepiploic artery (RGEA) 2/2, and saphenous vein graft (SVG) 0/2). LITA-RA composite grafting in off-pump coronary artery bypass enables arterial multivessel revascularization using an aortic no touch technique. This can be done with minimum postoperative complications and without risk of cerebral infarction even in patients at high risk for extracorporeal circulation (ECC). (Ann Thorac Cardiovasc Surg 2002; 8: 204–8)

Key words: coronary artery disease, off-pump coronary artery bypass, left internal thoracic artery, radial artery, composite graft

Introduction

It has been clearly demonstrated that bypassing the left anterior descending coronary artery (LAD) with a left internal thoracic artery (LITA) significantly improves long-term survival.[1)] Consequently, efforts have been made to increase the number of arterial grafts in coronary artery bypass grafting (CABG). However, the harvesting of multiple arterial conduits results in a more time-consuming and invasive surgery. Thus, we have used a LITA-radial artery (RA) composite graft. By using this technique, multiple arterial CABG is possible with only two grafts.[2-5)] The off-pump CABG technique is useful for patients who are at high risk for extra-corporeal circulation and also to avoid cannulation of the severely atherosclerotic ascending aorta. In our department, the LITA-RA composite graft has been used in order to perform multi-vessel arterial bypass grafting using the aortic no touch technique. Here, we report the early result of the LITA-RA composite graft.

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Patients and Methods

Patients (Table 1)

Between July 1998 and October 2001, 50 patients received off-pump CABG, among them 15 patients had LITA-RA

Table 1. Patients characteristics

Case	Age (y)/sex	Diagnosis	Timing	CAD	Concomitant disease	Intervention
1	66/M	UAP	Urgent	LMT+2VD	CVD, bad aorta	
2	68/M	AMI, UAP	Semi-urgent	2VD	CVD, DM, CRD	PTCA
3	78/M	AP	Elective	LMT+2VD	HL	
4	74/M	OMI, AP	Elective	2VD	CVD	PTCA
5	70/F	OMI, AP	Elective	1VD	DM, HL	PTCA
6	73/F	OMI, UAP, CHF	Elective	3VD	DM, CRD	PTCA×4
7	66/F	OMI, AP	Elective	3VD	DM, HL	PTCA×4
8	69/F	AMI, UAP	Urgent	LMT+2VD	RA	
9	68/M	UAP, OMI, CHF	Elective	3VD	CRD	
10	69/F	AMI	Elective	LMT+3VD	Porcelain aorta	PTCA (perforation)
11	77/M	AP	Elective	LMT		
12	65/M	AP	Elective	LMT+RCA	CVD, DM	
13	83/M	AMI	Elective	2VD		PTCA (RCA)
14	64/M	OMI	Elective	3VD	ASO	PTCA (RCA)
15	79/M	OMI, CHF	Elective	2VD		
Mean±SD	71.3±5.8					

UAP, unstable angina pectoris; AMI, acute myocardial infarction; AP, angina pectoris; OMI, old myocardial infarction; CHF, congestive heart failure; CAD, coronary artery disease; LMT, left main trunk disease; VD, vessel disease; CVD, cerebral vascular disease; DM, diabetes mellitus; CRD, chronic renal dysfunction; HL, hyper lipidemia; RA, rheumatic arthritis; ASO, arteriosclerosis obliterans; RTCA, percutaneous transluminal coronary angiography; RCA, right coronary artery

composite grafts. Patient ages ranged from 64 to 79 years old (mean±SD: 71.3±5.8); there were 10 males and 5 females. Three emergent surgeries were performed for unstable angina including two cases of post myocardial infarction (MI) angina. Elective surgeries were done for seven effort angina cases, three congestive heart failure cases, and two acute myocardial infarction cases (significant stenosis remained even after the catheter intervention). Coronary artery disease consisted of left main trunk lesion; six cases, three vessel disease; four cases, two vessel disease; four cases, one vessel disease; one case. Regarding preoperative concomitant disease, three patients had renal dysfunction (creatinine>2.5), four had cerebrovascular disease (cerebral infarction), five had diabetes mellitus, one had rheumatic arthritis and one had arteriosclerosis obliterans. Heavy calcification (porcelain aorta) and atherosclerosis of the ascending aorta was recognized as the so-called bad aorta in two cases. In eight cases, catheter intervention was performed up to four times. After the surgery, all patients received coronary artery angiography.

Surgical technique

Preparation of the LITA was performed using the skeletonization technique. During LITA harvesting, dissection of the RA was performed on the nondominant arm by use of a harmonic scalpel. Diluted papaverine with heparinized blood was injected into the lumen of the artery. A Y anastomosis between the LITA and RA was created with a continuous 8-0 monofilament suture (Fig. 1). The clamp was removed, and the LITA and RA were

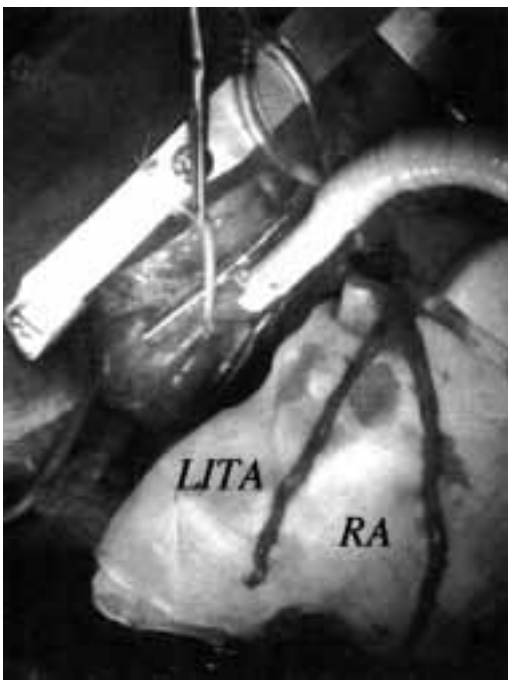

Fig. 1. LITA-RA composite graft.
LITA-RA composite graft was created before distal anastomoses.

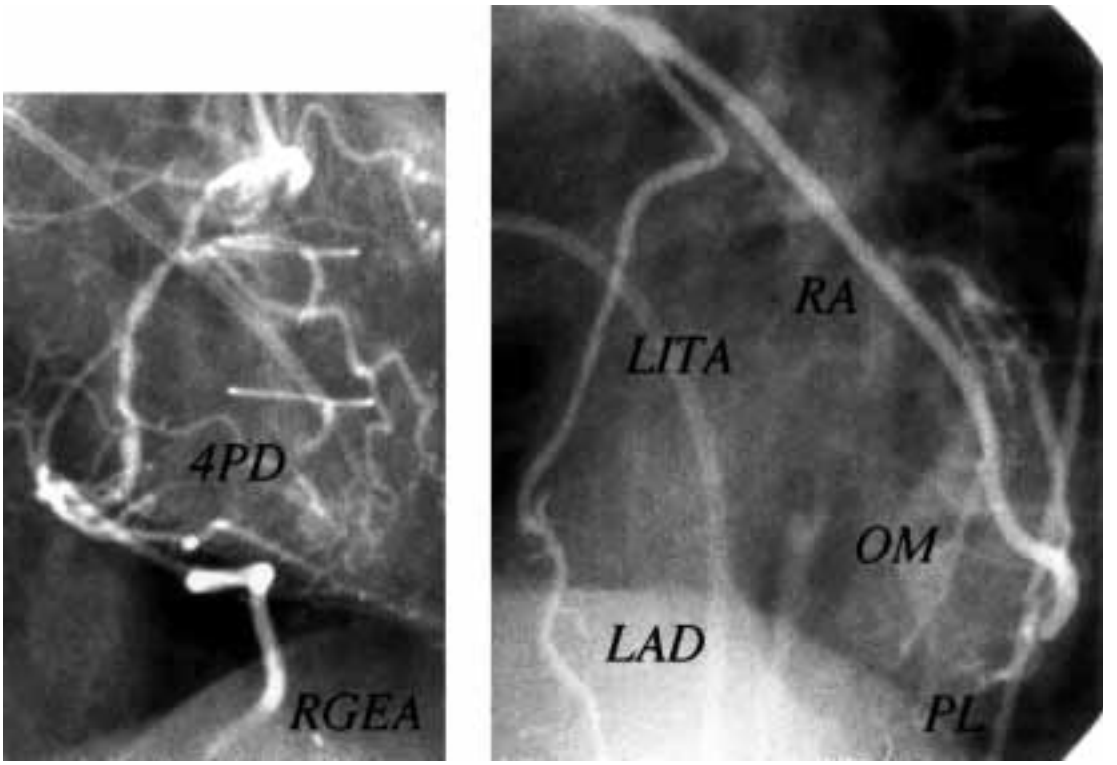

Fig. 2. Postoperative coronary angiography of case 9.
Postoperative coronary angiography of case 9 shows good flow of four anastomoses of off-pump bypass (LITA-LAD-RA-Dx-OM, RGEA-4PD).

checked for adequacy of flow and pulse. Off-pump CABG was undertaken using a sucking type stabilizer. At first, the LITA-LAD anastomosis was constructed. Then the RA was anastomosed to the diagonal branches and circumflex (CX) branches using sequential anastomoses. In the case of three vessel disease, right internal thoracic artery (RITA) or RGEA was anastomosed to the branches of the right coronary artery (RCA). Figure 2 shows postoperative coronary angiography (CAG) of case 9 in which four branches were revascularized (LITA-LAD-RA-Dx-OM, RGEA-4PD).

Results (Table 2)

Twelve elective operations and three urgent operations were undertaken for unstable angina. Two to four (mean 2.6±0.7) anastomoses of off-pump CABG were performed per patient. In all cases the aortic no touch technique was used. There was no case the which converted to the conventional CABG with ECC. Complete revascularization was possible in 12 cases out of 15. Mean operating time was 334.5±53.4 min. Mean intra-operative blood loss was 595.3±374.6 ml, and nine patients received the operation without blood transfusion. Neither postoperative intra aortic balloon pumping (IABP) support nor additional bypass grafting, which means ITA hypoperfusion, was needed. One patient who had severe stenosis of the left iliac artery received simultaneous operation with endarterectomy of the iliac artery. There was no perioperative myocardial infarction or cerebrovascular disorder, but in one case postoperative CAG caused cerebral infarction two months after surgery. All of the composite grafts were patent except for vein grafts. There were no hospital deaths. There was no ITA hypoperfusion.

Discussion

The ITA is chosen in CABG because of its superior patency. So, efforts have been made to increase the number of arterial grafts such as bilateral ITAs, the GEA,[6] and the RA.[7] However, the harvesting of multiple arterial conduits is more time-consuming. In order to avoid placing vein grafts into a severely atherosclerotic ascending aorta, Mills introduced the concept of anastomosing an-

Table 2. Results of 12 elective operations and three urgent operations

Case	Operation	Complete	OP time (min)	Blood loss (ml)	Blood transfusion (u)	Complication	Result
1	LITA-LAD-RA-Dx-PL (3)	C	360	880	2		Alive
2	LITA-LAD-RA-OM1-PL2 (3)	C	320	465	Non	Cerebral infraction (2 M)	Alive
3	LITA-LAD-RA-OM (2)	C	325	355	Non		Alive
4	LITA-LAD-RA-D1-OM (3)	C	292	186	Non		Alive
5	LITA-LAD-RA-D1 (2)	C	290	250	Non		Alive
6	LITA-LAD-RA-CxPL (2)	IC	275	220	Non		Alive
7	LITA-LAD-RA-D3-CxPL (3)	IC	355	421	Non		Alive
8	LITA-LAD-RA-OM (2)	C	295	587	4		Alive
9	LITA-LAD-RA-OM1-PL1, RGEA-4PD (4)	C	455	845	Post op 4		Alive
10	LITA-RA-LAD&PL, RITA-SVG-4PD-4AV (4)	C	395	250	2	Transient recurrence nerve paralysis	Alive
11	LITA-OM1-RA-LAD (2)	C	310	235	Non		Alive
12	LITA-LAD-RA-HL, RGEA-4PD (3)	C	361	1,216	Post op 4		Alive
13	LITA-LAD-RA-D1 (2)	C	285	835	Post op 6	Bleeding	Alive
14	LITA-LAD-RA-OM (2)	C	410	1,318	Non		Alive (TEA, simultaneous operation)
15	LITA-LAD-RA-D1 (2)	IC	290	867	Non		Alive
Mean±SD	2.6±0.7		334.5±53.4	595.3±374.6	1.5±2.1		

LITA, left internal thoracic artery; LAD, left anterior descending artery; Dx, diagnosis; RA, radial artery; PL, posterolateral artery; OM, obtuse marginal artery; RGEA, right gastroepiploic artery; RITA, right internal thoracic artery; SVG, saphenous vein graft; AV, atrioventricular artery; HL, high lateral branch; C, complete revascularization; IC, incomplete revascularization; TEA, thromboendarterectomy

other bypass graft to an attached ITA.[8] A composite graft was proposed for complete arterial revascularization in multivessel coronary artery disease (CAD) with only two grafts. Tector et al.[2] and Sauvage et al.[3] have used a composite graft in which the RITA is connected to the LITA. Dissection of bilateral ITA may cause sternal dehiscence, particularly in diabetic patients with low cardiac function.[9] The RA was introduced by Carpentier et al. as a conduit in CABG in 1975.[10] And after the introduction of gentle harvesting and medical treatment of the RA, excellent results were reported by Acar et al.[7] and Calafiore et al.[11] The RA is easy to handle and its small size compared with a vein graft matches the size of the coronary artery and other arterial conduits. Also, the RA can be dissected during preparation of the LITA. Tatoulis et al.[4] and Sundt et al.[5] have used a composite graft with the LITA and RA. The RA is able to cover all regions of the coronary artery when inflow of the RA is brought to LITA not to the ascending aorta. Because of RA's relatively small-diameter, anastomosis between LITA and RA is technically easier compared with the thick aortic wall. A LITA-RA composite graft is able to achieve complete revascularization with only two grafts using sequential anastomoses. It saves the conduit, and reduces operating time. And, by harvesting only one ITA (LITA), the risk of sternal complication can be reduced. There is no need for proximal anastomosis on the atherosclerotic ascending aorta, and it eliminates the embolic complications associated with manipulation of the aorta.

The advantages of off-pump CABG are that it eliminates the bad influence of the extracorporeal circulation and that cannulation of the calcified and atherosclerotic ascending aorta can be avoided.[12,13] In the beginning era of off-pump, the quality of anastomoses is questionable and the number of revascularized coronary arteries was limited.[14] Recent advances with the use of a suction stabilizer[15] and a CO_2 blower,[16] makes it possible to revascularize even the circumflex marginal arteries safely and easily in a beating heart.

A LITA-RA composite graft in the off-pump CABG is very beneficial because both techniques enable aortic no touch. There is a concern whether the flow reserve in the LITA is sufficient or not, because total bypass the flow is dependent on the flow in the LITA.[17] Wenddler et al. reported adequate blood supply can be confirmed through the LITA using a Doppler guide wire measurement.[18]

Also, based on our limited experience, there was no LITA hypoperfusion syndrome, no need for intra-aortic balloon pumping, and no need for an additional bypass even in emergent cases. Postoperative coronary angiography confirmed patency of all the graft and dilatation of the proximal portion of LITA conduit. It is considered that the arterial conduit has autoregulation of blood supply which will be an advantage of the arterial conduit.

Conclusions

LITA-RA composite grafting in off-pump coronary artery bypass enables arterial multivessel revascularization using an aortic no touch technique. This can be done with minimal postoperative complication and without risk of cerebral infarction even in patients at high risk for ECC.

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