Original Article

Free Right Internal Thoracic Artery as a Second Arterial Conduit: Modification of Proximal Anastomosis for Improvement of Graft Patency

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The applicability of the right internal thoracic artery (RITA) for coronary artery bypass grafting (CABG) is higher when used as a free graft than as a pedicled graft. However, the technical difficulty of directly connecting the proximal end of the free RITA to the much larger aorta leads to poor patency. To overcome this technical limitation, we have used a modification that places the proximal end of this artery onto the hood of an accompanying vein graft at the aortic anastomosis instead of directly onto the aorta. We performed isolated CABG on 43 patients using the free RITA as a second arterial graft following pedicled left internal thoracic artery (LITA) grafting. The mean patient age was 60 years and 38 patients were male. There was no mortality and no incidence of morbidity related to free RITA use. Postoperative coronary angiography performed in all patients revealed that all proximal anastomoses were widely patent, making the patency rate of the free RITA 100%. With these encouraging results, the free RITA graft with the described modification is thought to be a more promising second arterial graft with greater versatility than the pedicled graft. The long-term evaluation of a large patient population will determine the significance of this modification. (Ann Thorac Cardiovasc Surg 2001; 7: 155–8)

Key words: coronary artery bypass grafting (CABG), right internal thoracic artery, free arterial graft, arterial graft

Introduction

Grafting the left internal thoracic artery (LITA) to the left anterior descending coronary artery (LAD) is the gold standard in coronary artery bypass grafting (CABG) due to its excellent patency and its efficacy in improving long-term survival.[1)] Surgeons have sought additional arterial conduits to complement the LITA and the right internal thoracic artery (RITA) appeared promising because its propensities are similar to those of the LITA. The patency of the free RITA graft shortly after surgery, however, is not as good as that of the pedicled graft because connecting the proximal end of the free RITA to the much larger aorta is technically difficult.[2)] To improve the patency of the free RITA graft, we placed the proximal end of the free RITA onto the hood of an accompanying vein graft at the aortic anastomosis. This report describes our experience using the free RITA as a second artery graft following pedicled LITA grafting.

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Patients and Methods

Between January 1997 and October 2000, we performed isolated CABG on 43 patients, using the free RITA as a second arterial graft following pedicled LITA grafting. The mean patient age was 60 years (range, 18 to 74 years) and 38 patients were male. Table 1 summarizes the patient characteristics before surgery. In addition to bilateral internal thoracic artery grafts, all patients had supplemental vein grafts or arterial grafts or both. The definition of the free RITA as a second arterial graft excluded:

Table 1. Patients characteristics

No. of patients	41
Age (years)	60.0 ± 9.4
Sex (M/F)	38 / 5
Prior infarction	33 (77%)
Unstable angina	11 (26%)
IABP support	5 (12%)
Diabetes	18 (42%)
Hypercholestelemia	19 (44%)
Smoking	25 (58%)
Hypertension	28 (65%)
Angina class[a]	3.0 ± 0.5
Left ventricular ejection fraction (%)	54 ± 13
Coronary lesions	
2 vessel disease	1 (2%)
3 vessel disease	20 (47%)
LMT+2 vessel disease	1 (2%)
LMT+3 vessel disease	21 (49%)

[a]Angina classification by the Canadian Cardiovascular Society, IABP: intraaortic balloon pump, LMT: left main trunk disease.

(1) the use of the RITA as a pedicled graft, (2) the proximal end of the RITA connected to the LITA as a composite graft, and (3) the use of the RITA as a primary arterial conduit without other arterial grafts. The use of the free RITA as a second arterial graft was indicated by: (1) a large target vessel suitable for revascularization with an arterial conduit, (2) a patient with a chronological or physically compatible age of less than 70 years, and (3) a RITA with an internal diameter of 1.5 mm or larger.

After a median sternotomy was made, the LITA and RITA were harvested using a semiskeltonization technique with the use of electrocautery and hemoclips. After systemic heparinization, both arteries were divided distally and prepared by intraluminal and topical administration of diluted papaverine solution. To obtain the maximal length of the RITA, the proximal part of the RITA was mobilized as close to its origin as possible; this mobilization was completed after cardiopulmonary bypass, if necessary, was initiated. During cardiopulmonary bypass, the body temperature was lowered to 30°C. Myocardial protection was achieved by intermittent antegrade cold blood cardioplegia, topical cooling, and terminal warm blood cardioplegia. In general, the LITA was anastomosed to the LAD and the free RITA was used to bypass to the left coronary system. All distal anastomoses were constructed with continuous 8-0 polypropylene sutures. The proximal end of the free RITA was connected to the hood of an accompanying vein graft at the aortic anastomosis in an end-to-side fashion with continuous 7-0 polypropylene sutures. Thus, the free RITA was not anastomosed directly to the aorta. To avoid excessive angularity between the free RITA and the vein graft, we made large proximal anastomoses that were three times the internal diameter of the proximal end of the RITA in length (Fig. 1).

Fig. 1. Proximal anastomosis of free right internal thoracic artery graft (RITA). The proximal end of the artery is anastomosed to the hood of the accompanying vein graft in an end-to-side fashion (arrows).

Table 2. Distal anastomotic sites

Conduit	LAD	Dx	RCA	Cx
Free RITA	3	13	3	24
Pedicled LITA	40	2		1
RGEA			7	
Radial artery				1
Vein		20	35	36

RITA: right internal thoracic artery, LITA: left internal thoracic artery, RGEA: right gastroepiploic artery, LAD: left anterior descending artery, Dx: diagonal branch, RCA: right coronary artery, Cx: circumflex coronary artery.

Due to the probability that use of bilateral internal thoracic artery grafts in diabetic patients is associated with an increased risk of deep sternal wound infection,[3,4] early postoperative blood glucose levels were strictly controlled. When the blood glucose levels increased beyond 200 mg/dL, continuous intravenous insulin infusion was initiated and the levels were maintained between 150 and 200 mg/dL.

Results

Intraoperative findings

The free RITA was of sufficient length to reach the target vessel to be revascularized in all but 2 cases. In each of these two cases, the free RITA did not reach the target vessel because the heart was hypertrophic; the diagonal branches were then grafted instead of the circumflex arteries. The sites of free RITA distal anastomosis and other conduits are listed in Table 2. The number of distal anastomoses per patient was 4.3±0.7. Cardiopulmonary bypass time and aortic cross clamp time were 212±30 min and 119±33 min respectively.

Early mortality and morbidity

All 43 patients survived the operations and were discharged from the hospital in good condition. All of the free RITAs harvested were acceptable as arterial conduits. In terms of morbidity, there were no incidence of stroke, wound infection, or perioperative myocardial infarction as indicated by a new Q wave and an increase in the serum creatine kinase-MB (CK-MB) level of more than 50 IU/L. The average CK-MB level measured on the first postoperative day was 14±17 IU/L. One patient underwent a reoperative procedure to control postoperative bleeding unrelated to free RITA use. Two patients experienced respiratory dysfunction and required prolonged mechanical ventilation.

Graft patency

Postoperative coronary angiography was performed on all patients before their discharge from the hospital. All proximal anastomoses of the free RITA grafts were widely patent. One distal anastomosis of the free RITA graft was 50% stenotic but all other distal anastomoses were widely patent. Consequently, the overall patency rate of the free RITA graft was 100%. The patency rate of the LITA, the saphenous vein, the right gastroepiploic artery and the radial artery was 100% (43/43), 93% (85/91), 100% (7/7) and 100% (1/1), respectively.

Follow-up results

During the follow-up period of 19±10 months (range, 1 to 33 months), no patient died or experienced myocardial infarction. Angina recurred in 2 patients. One of the two patients underwent successful catheter intervention 12 months after surgery for anastomotic stenosis of the LITA to the marginal artery. In another patient, coronary angiography performed 8 months after surgery revealed that the free RITA graft, which had been anastomosed to the diffusely narrowed circumflex coronary artery, was occluded and a beta-blocker was started to control the angina. Consequently, 41 patients were in the Canadian Cardiovascular Society angina class 1 and 2 patients in class 2.

Comment

Following the landmark report of Loop and colleagues, revascularization of the LAD with the LITA has become a gold standard because of the improved long-term survival and reduced morbidity from the graft's excellent patency.[1,5] This success has prompted surgeons to seek additional arterial conduits to overcome vein graft diseases recognized during the late phase. The RITA appears most favorable due to the fact that it has the same propensities as the LITA. However, its length is often insufficient to reach distal coronary arteries when it is used in a pedicled conduit, a fact that limits its availability. If the RITA is used as a free graft, it becomes possible to place anastomoses more distally, thus increasing its applicability for arterial revascularization,[6] but the patency of the internal thoracic artery as a free graft may not be as good as that of the pedicled graft as reported by Loop and colleagues.[2] This reduced patency appeared to be due to the technical difficulty of directly connecting the free internal thoracic artery to the much larger aorta. The internal thoracic artery in Japanese people is

smaller than in Western people, and if the proximal end of the free RITA were anastomosed directly to the aorta in Japanese patients, the patency would be even poorer. To overcome this technical limitation, we placed the proximal end of the RITA onto the hood of an accompanying vein graft at the aortic anastomosis. This technique was successfully applied on one patient and reported by Barner in 1972.[7] Our angiographic evaluation showed that the patency rate was 100% and all proximal anastomoses were widely patent even in small RITAs.

The use of bilateral internal thoracic arteries is believed to be a risk factor for deep sternal wound infection. However, we did not experience this complication, most likely as a result of our aggressive management of blood glucose levels after surgery. Consequently, there were no perioperative complications related to free RITA use and the follow-up results were satisfactory. These findings strongly suggest that the described modification of the free RITA proximal anastomosis is a useful option for achieving good patency, particularly in cases in which the RITA is small.

The present study focused on technically improving the initial patency of the free RITA. It did not show the effect of initial patency on later patency. Loop and colleagues reported that when early occlusion was prevented in the free RITA, the graft had long-term patency comparable to that of the pedicled graft.[2] We have noted that in repeat coronary surgery, only minimal atherosclerotic change is seen at the hood of the vein graft, even many years after the primary surgery. Buxton and colleagues also described that proximal anastomosis of an arterial conduit to the hood of an old vein graft was a safe alternative in repeat coronary surgery.[8] Therefore, we believe that when early occlusion is prevented in the free RITA by the described modification of the proximal anastomosis, the RITA will function well and good long-term patency will be achieved. In addition, we expect the improved early patency of the free RITA as a second arterial conduit to lead to greatly improved long-term results, due to the fact that recent studies have confirmed that the use of bilateral internal thoracic arteries, including a free RITA, is more effective than using a single internal thoracic artery in improving long-term survival and in reducing morbidity.[9-11] Long-term evaluation and a large number of patients are needed to confirm the validity of our expectation.

In conclusion, the applicability of the RITA as a second arterial graft following pedicled LITA grafting increases when it is used as a free graft, compared with when it is used as a pedicled graft. The described modification of the free RITA proximal anastomosis is very advantageous to achieve excellent early patency without deteriorating effects.

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