Original Article

The Efficacy and Safety of Additional Bypass Graft during Isolated Coronary Artery Bypass Grafting

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In 19 patients with an undesirable hemodynamic condition (n=15) or with regional asynergy and coexistent ST-T change (n=4) during isolated coronary artery bypass grafting (CABG) surgery, one (n=17) or two (n=3) additional saphenous vein grafts were placed onto left anterior descending (LAD) (n=16), right (n=4), and left circumflex (LCx) (n=2) coronary arteries. Diagnosis of the cause of the suboptimal condition was insufficient graft flow in 16 patients, and spasm of the ungrafted coronary artery in 3. Additional myocardial ischemic time was 17±9 minutes, and the graft flow was 59±25 ml/min. Additional bypass was effective in 94.5%. Eighteen patients could be weaned from cardiopulmonary bypass, and 17 (89.5%) survived and were discharged from hospital. Median duration of mechanical ventilatory support and intensive care unit stay was 15 hours and 4 days, respectively. During 63±44 months follow-up, the additional graft was occluded and the treadmill test was positive for ischemia in 2 patients, and one child patient is now considered for redo CABG. Placement of additional bypass grafts thus appeared to be an effective and relatively safe strategy, although the decision has to be made cautiously. (Ann Thorac Cardiovasc Surg 2002; 8: 102–5)

Key words: additional bypass graft, CABG, LOS

Introduction

Undesirable hemodynamic condition or poor myocardial contractility is occasionally encountered during coronary artery bypass grafting (CABG) surgery. Our basic strategy for such cases is to place additional bypass grafts whenever possible. In the present study, the efficacy and safety of this strategy are retrospectively investigated.

Patients and Methods

From March 1987 until February 2000, 1,287 patients underwent isolated CABG through median sternotomy and using cardiopulmonary bypass (CPB) at moderate hypothermia. Additional bypass grafting was indicated in 19 patients (1.5%) because of failure to wean from CPB in 15 and because of regional myocardial asynergy and coexistent ST-T change on electrocardiography in 4. Patient demographics are shown in Table 1. There was no reoperative case. Four cases were emergency operation (acute myocardial infarction in 2, and unstable angina in 2), and an intra-aortic balloon pump (IABP) was already in place in 2 patients with acute myocardial infarction. In all but 2 patients with acute myocardial infarction, the left or bilateral internal thoracic artery had been used. Diagnosis of the cause of the suboptimal condition during CPB was insufficient graft flow in 16 patients, and spasm of the ungrafted coronary artery in 3. Additional bypass was anastomosed with (n=17) or without (n=2) aortic cross clamping under ventricular fibrillation at moderate hypothermia. A saphenous vein was used as a bypass conduit in all cases. Early and late clinical results are investigated. Data are expressed as mean±standard deviation.

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Table 1. Patient demographics

Male:female	17:2	
Age	58±14	(7-75)
Number of diseased vessel		
1VD	1	
2VD	6	
3VD	12	
LMT	3	
LVEF (%)	67±15	(42-82)
Number of bypass grafts (before addition)	3.1±1.1	

VD: vessel disease, LMT: left main trunk,
LVEF: left ventricular ejection fraction

Table 2. Number and target vessels of additional bypass grafts

Number of additional bypass	1 (n=16)		2 (n=3)	
Target vessels	LAD	13	LAD+LCx	1
	LCx	0	RCA+LCx	1
	RCA	3	RCA+RCA	1

LAD: left anterior descending artery,
LCx: left circumflex artery, RCA: right coronary artery

Results

Number of the additional bypass grafts and their target vessel are shown in Table 2. The additional bypass grafts were placed onto left anterior descending (LAD) (n=16), right (n=4), and left circumflex (LCx) (n=2) coronary arteries. In 3 patients, it was placed onto vessels that had not been scheduled for revascularization at first. Perioperative variables are given in Table 3. Satisfactory graft flow was obtained in the majority of patients. Although duration of operation and CPB got remarkably longer, all but one patient who failed to wean from CPB were successfully separated from CPB. In 4 patients with myocardial asynergy and coexistent ST-T change, previous abnormal findings disappeared. Therefore, additional bypass was effective in 94.5% (18/19). In 6 patients, IABP was also used to obtain a better hemodynamic condition. In a 52-year-old male who underwent 4 CABGs and left ventricular aneurysmectomy, however, marked improvement could not be obtained even after placement of an additional bypass graft with satisfactory flow. He could be weaned from percutaneous cardiopulmonary support 3 days later, but he suffered ischemic damage of the lower limb (serum creatinine phosphokinase=46,000 IU/l). Mediastinitis followed and he died 9 months later. In another 59-year-old male, fatal pulmonary emboli and gangrenous cholecystitis occurred. Therefore, hospital mortality was 10.5%. Other morbid events were acute renal failure in 2 patients, and new ST-T change on electrocardiography in 3. Fifteen patients (79.0%) were free from morbidity. Maximal doses of inotropes were less than 10 μg/kg/min in 13 patients (68.4%), although serum creatinine phosphokinase and its myocardial fraction were significantly elevated in the majority of the patients. Thirteen patients required mechanical ventilatory support for

Table 3. Perioperative variables

	Mean	Median	Range
Operation time (min)	423±120	415	(250-800)
CPB time (min)	215±65	219	(116-379)
ACC time (before addition, min)	54±18	49	(19-89)
Additional ACC time	17±9	12	(0-41)
Graft flow (ml/min)	59±25	40	(15-120)
IABP	6		
PCPS	1		
New ST-T change	3		
Peak CPK (IU/l)	3,615±2,356	2,867	(554-46,000)
Peak CPK-MB (IU/l)	95±77	70	(45-900)
ICU stay (days)	9.4±19.9	4	(2-91)
Mechanical ventilation (hrs)	44±69	15	(3.5-110)

CPB: cardiopulmonary bypass, ACC: aortic cross clamping, IABP: intra-aortic balloon pumping, PCPS: percutaneous cardiopulmonary support, CPK: creatinine phosphokinase, CPK-MB: myocardial fraction of CPK, ICU: intensive care unit less than 24 hours, and were discharged from the intensive care unit within 5 days (median duration; 15 hours and 4 days, respectively).

Patients have been followed up for 63±44 months. Follow-up treadmill test and angiography was performed in 17 (100%) and 12 (58.8%) of 17 survivors, respectively. One left internal thoracic artery graft in which insufficiency had been suspected was occluded. The additional bypass was patent in 9 patients and occluded in 3. In 2 of 3 patients whose additional graft was occluded, the treadmill test was positive for ischemia, and one child patient with Kawasaki disease is now considered for redo CABG.

Discussion

Low output syndrome is one of the most important causes of operative mortality and morbidity of CABG.[1] Insufficient graft flow is frequently responsible for low output syndrome during CABG. When we encounter an undesirable hemodynamic condition or myocardial contractility during CABG, treatments of choice are 1) IABP support alone, 2) revision of the anastomosis, and 3) placement of additional bypass grafts. IABP is often effective and relatively safe. However, its effect is often limited in the presence of graft failure, and IABP sometimes causes fatal vascular injury, embolism, ischemic necrosis of the lower limb and so forth.[2,3] Moreover, angina may persist. Acceptable quality of the anastomosis and proper anastomotic site are minimal prerequisites for successful CABG. Revision of the anastomosis using the same graft conduit can be very effective in case of technical failure. However, various factors can cause insufficient graft flow.[4] When other factors are also responsible, revision does not improve or may even worsen the situation. Revision may cause severe vasospasm of the arterial graft or injury of the target vessel, and is more technically demanding. Therefore, in every case that insufficient graft flow is probable, our basic strategy has been addition of bypass grafts before inserting IABP. Although clinical courses were remarkably delayed in comparison with the usual cases, most patients had an uncomplicated postoperative course and about 90% of the patients survived. The results appear to be acceptable. Even if additional bypass grafts are placed, however, sufficient effects are not always obtained especially when the quality of the target vessel is poor. Myocardial ischemic time gets longer, which may cause more serious myocardial injury. Suboptimal long-term patency of the vein graft is another difficult problem.[5] Therefore, the decision to place additional grafts has to be made cautiously. On the other hand, the decision should be made early to avoid systemic and myocardial hypoperfusion at normothermia, and unnecessary elongation of CPB and operation time, all of which compromise postoperative convalescence of the patients. Accordingly, we check the quality of the anastomosis over and over again during the procedure, and we evaluate the graft flow pattern during CPB to find out insufficient revascuralization as early as possible. If a good flow pattern is not obtained, we check myocardial contraction using transesophageal echocardiography. However, interpretation of poor contractility is sometimes difficult, especially in patients that asynergy had been already present preoperatively. Moreover, reliable signals of transit time flow meter are not always obtained, and interpretation of low graft flow rate is sometimes difficult.[4,6] In only 4 patients actually, the addition of bypass grafts was decided on, mainly based on poor flow pattern and regional asynergy. In most of the other 15 patients, however, some undesirable findings were noted before trying to wean from CPB. The decision to place additional grafts has been made very late so far, and we should try to make an appropriate decision at the optinum time.

Limitation of the study

This is a purely observational study. We consider placement of additional bypass grafts in every case that insufficient flow is suspected. Conversely, we do not place an additional graft if revascularization appears to be complete and preoperative cardiac dysfunction appears to be the main problem. Therefore, the superiority of our strategy to the other ones such as IABP support alone can not be documented from this study. Preoperative left ventricular function was fairly well preserved in most of our patients. The results may be different when only patients with cardiac dysfunction are included. In addition, patients with concomitant valvular disease were not included in the present study.

Conclusion

Additional bypass grafts were placed in 19 patients with an undesirable hemodynamic condition or poor regional myocardial contraction during isolated CABG. Additional bypass was effective in 94.5%. Eighteen patients could be weaned from CPB, and 17 of them survived and were discharged from hospital. Placement of an additional bypass appeared to be an effective and relatively safe method in our patient population.

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