Original Article

Coronary Artery Bypass Grafting For Acute Myocardial Infarction in Stent ERA

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Purpose: We evaluated a treatment strategy for acute myocardial infarction (AMI) that percutaneous coronary intervention (PCI) is performed on a culprit lesion unless the culprit is an unprotected left main trunk. Emergent coronary artery bypass grafting (CABG) is done when the culprit is a left main trunk and a mechanical complication exists.
Methods: From 1997 to 2008, 22 and 232 patients underwent CABG for AMI and non-AMI, respectively. Of the 22 patients of AMI, PCI was performed in 12 patients and not performed in 10 patients before surgery. We investigated complication, intubation period, in-hospital mortality and hospitalization period.
Results: No in-hospital mortality was observed in all 22 AMI patients. There was no difference in in-hospital mortality and complication between the AMI and the non-AMI patients. No significant difference was found in hospital stay, complication, intubation period, in-hospital mortality and hospitalization period between patients who received preceding PCI and not.
Conclusions: These results suggest that our treatment strategy is reasonable. Further studies will be warranted to clarify the role of preceding PCI.

Key words: coronary artery bypass grafting, acute myocardial infarction, percutaneous coronary intervention

Introduction

Treatment for acute myocardial infarction (AMI) is based on early restoration of interrupted coronary flow in the acute phase. Pharmacological thrombolysis, percutaneous coronary intervention (PCI), and coronary artery bypass grafting (CABG) are performed following emergent coronary angiography (CAG).

In-hospital mortality of CABG for AMI is 7.9%–19.2 %[1, 2] and still high compared to 4.6%–9.8 % of PCI[3, 4] Patients who were previously treated with CABG now undergo PCI because of this relatively low mortality. Furthermore, a drug eluting stent has shown superior restenosis risk and is now applied to AMI treatment. The application of a stent to AMI is increasing.[5]

In our institution, the treatment strategy for AMI is to perform PCI on a culprit lesion of AMI unless the culprit is an unprotected left mail trunk (LMT) and an anatomically unfavorable lesion for PCI. Emergent or urgent CABG is performed when the culprit is unprotected LMT and a mechanical complication of AMI exists. Elective CABG is performed on remnant multiple lesions after a primary PCI and anatomically difficult lesion for PCI before hospital discharge when patients suffers angina due to LMT and multi-vessel disease.

We performed CABG solely or combined with PCI for AMI patients, based on this strategy. We investigated

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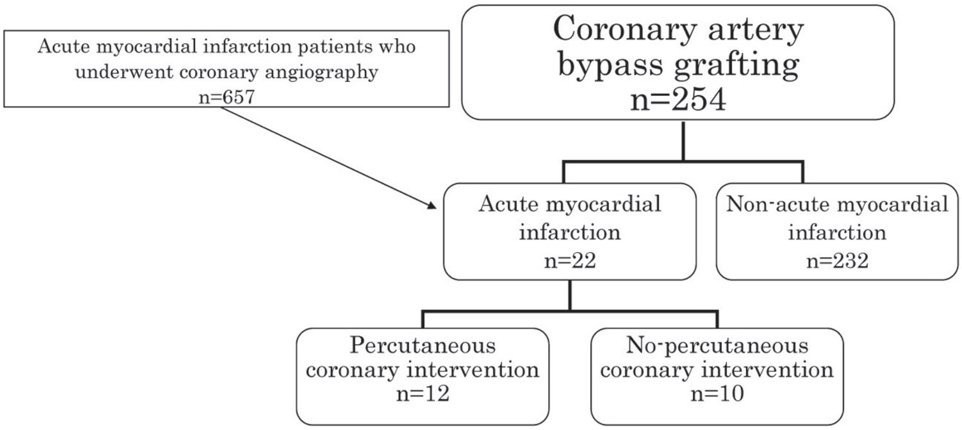

Fig. 1 A total of 254 coronary artery bypass graftings were performed. Twenty two patients were due to acute myocardial infarction, and 232 were non- acute myocardial infarction. Of 22 acute myocardial infarction patients, 12 patients underwent preceding percutaneous coronary intervention.

outcomes of CABG for AMI patients to verify that our strategy is reasonable. Also, the role of PCI before CABG is evaluated by comparing clinical outcomes between patients who received PCI and did not receive PCI.

Patients and Methods

From July 1997 to November 2008, in our institution, 254 patients underwent CABG and off-pump CABG (OPCAB) for AMI, angina, old myocardial infarction and ischemic heart failure. The diagnosis of AMI was made, based on a cardiac enzyme increase, ST elevation in the electrocardiogram and clinical symptoms. To evaluate outcomes of CABG for AMI patients who were treated with our strategy, we divided these 254 patients into 2 groups, which were AMI (group A) and non-AMI patients (group B) (**Fig. 1**). We investigated patient basic characteristics such as age, sex, chronic renal failure (CRF), which is defined, to be over 1.5 mg/dl of serum creatinine, diabetes mellitus (DM), hypertension, total cholesterol (T. chol), creatinine phosphokinase (CK) and myocardium isoenzyme (CK-MB) at hospital admission before CAG, surgical procedures, the number of distal anastomosis, operation time and usage of intra aortic balloon pumping. The indication for emergent or urgent CABG was unprotected LMT as a culprit and mechanical complication of AMI. Remnant multiple lesions after primary PCI and anatomically difficult lesions for PCI were qualified for elective CABG. Conventional CABG was performed when patients did not present with calcification of the ascending aorta and a history of cerebral infarction while off-pump OPCAB was done, when there were these complications. To evaluate clinical outcomes, complications after surgery, intubation period, in-hospital mortality and the hospitalization period were investigated.

Then, to evaluate effects of PCI before CABG for AMI patients, we allocated 22 patients into 2 groups according to whether PCI was performed (Group P) or not (Group N), before CABG (**Fig. 1**). We investigated patient basic characteristics and clinical outcomes in the same way as previously described. In these groups, coronary angiography (CAG) and PCI procedure were also investigated. All the AMI patients underwent emergent coronary angiography within 3 hours of hospital arrival. Stenosis was defined as significant when 2 orthogonal views showed at least 75 % of narrowing except in the left main trunk (LMT), which was defined as significant with 50 % narrowing. We performed PCI on the culprit artery of AMI when anatomically applicable.

Informed consent was obtained from each patient, and the study protocol was approved by the institutional research committee. Statistical analysis was performed by SAS software version 5.1. Continuous variables are expressed as mean ± SD. We used the t-test for continuous variables and Fisher's exact probability test for categorical variables. All P values are 2-tailed, and $p < 0.05$ is assumed as significant.

Results

Of 254 patients, 22 patients received CABG or OPCAB for AMI (group A) and 232 patients underwent CABG or OPCAB for angina, old myocardial infarction

Table 1

Group	A (AMI) (n = 22)	B (non-AMI) (n = 232)		p
Age	69 ± 11	69 ± 8.6	yo	0.96
Female	4/22	60/232		0.61
HT	59.1	69.8	%	0.34
DM	40.9	43.1	%	>0.99
T.Chol	146 ± 75	192 ± 38	mg/dl	<0.001
CRF	4.5	11.6	%	0.48
OPCAB	31.8	35.3	%	0.82
Distal anastomosis	2.4 ± 1.0	2.4 ± 0.9		0.89
OP time	315 ± 92	336 ± 88	min	0.3
IABP insertion	63.6	16.8	%	<0.0001
IABP duration	3.0 ± 2.2	2.3 ± 1.0	days	0.12
Concomitant Procedure				
AVR		5		
MVR	1	6		
AVR + MVR		1		
MVP	1	4		
TAP		1		
VSP closure	1			
Dor		2		
Tumor resection		1		
TAA resection		1		

AMI, acute myocardial infarction; AVR, aortic valve replacement; CRF, chronic renal failure; DM, diabetes mellitus; HT, hypertension; IABP, intra-aortic balloon pumping; MVP, mitral valve plasty; MVR, mitral valve replacement; OP, operation; OPCAB, off-pump coronary artery bypass grafting; TAA, thoracic aortic aneurysm; TAP, tricuspid annuloplasty; T.chol, total cholesterol; VSP, ventricular septal perforation

Table 2

Group	A (AMI) (n = 22)	B (non-AMI) (n = 232)		p
Complication after surgery	13.63636364	18.96551724	%	0.77
Intubation period after surgery	4.5 ± 5.0	1.7 ± 2.5	days	<0.0001
In-hospital mortality	0	2.155172414	%	>0.99
Hospitalization period	64 ± 32	35 ± 24	days	<0.0001

AMI, acute myocardial infarction

and ischemic heart failure (group B). Patients' basic characteristics are shown in **Table 1**. Between group A and B, no significant difference was observed except in T.chol and use of IABP. We used IABP in 63.6% of group A patients and in 16.8 % of group B patients (p <0.001). Clinical outcomes are presented in **Table 2**. In group A, no in-hospital mortality was observed. There was no significant difference in in-hospital mortality and complications after surgery between group A and B. However, the intubation period was 4.5 ± 5.0 days in group A and 1.7 ± 2.5 days in group B (p <0.0001). Hospitalization periods were 64 ± 32 and 35 ± 24 days in group A and B, respectively (p <0.0001).

Of 22 patients who underwent CABG for AMI, we performed PCI before the surgery in 12 patients (Group P). The other 10 patients did not undergo PCI before surgery (Group N). Basic characteristics in both groups are shown in **Table 3**. No significant difference was found in age, total cholesterol, hypertension, diabetes meritus, and chronic renal failure except female between the 2 groups.

CAG was performed within 12 hours from AMI onset in the 22 patients. CAG findings are shown in **Table 4**. None of the 12 patients suffered from an LMT lesion as a culprit in group P although 3 patients showed an LMT lesion in group N. A Cx lesion was found as a culprit in 3 patients of group P whereas No Cx lesion was observed as a culprit in group N (p = 0.08). There was no significant difference in the number of vessels, LMT lesion and

Table 3

Group	P (PCI + CABG) (n = 12)	N (CABG) (n = 10)		p
Age	72 ± 8	66 ± 13	yo	0.26
Female	0.0	40.0		0.03
HT	58.3	60.0	%	>0.99
DM	41.7	40.0	%	>0.99
T.Chol	167 ± 27	191 ± 73	mg/dl	0.35
CRF	0.0	10.0	%	0.45

CABG, coronary artery bypass grafting; CRF, chronic renal failure; DM, diabetes mellitus; HT, hypertension; PCI, percutaneous coronary intervention; T.chol, total cholesterol

Table 4

Group	P (PCI + CABG) (n = 12)	N (CABG) (n = 10)		p
Culprit				0.08
LMT	0	3		
LAD	2	3		
CX	3	0		
RCA	7	4		
Vessel number				0.6
2	2	3		
3	10	7		
LMT lesion	3 (25)	5 (50)	(%)	0.38
CK at hospital arrival	952 ± 1168	660 ± 505	mg/dl	0.48
CK-MB at hospital arrival	90 ± 100	64 ± 48		0.48

CABG, coronary artery bypass grafting; CK, creatinine phosphokinase; CK-MB, myocardium isoenzyme; CX, left circumflex artery; LMT, left main trunk; LAD, left descending artery; PCI, percutaneous coronary intervention; RCA right coronary artery

CK, and CK-MB between the 2 groups. We used a bare metal stent in 9 patients, and performed plain old balloon angioplasty in 3 patients. We performed a total of 657 CAGs for AMI during the same period of this study.

Indications for surgery are listed in **Table 5**. Surgical indications in group P were remnant multiple lesions in 11 patients and mitral regurgitation in 1 patient. In group N, indications were an LMT lesion in 3 patients, anatomical difficulty in 3, ventricular septal perforation in 1, and a failed PCI in 2. The time interval between the onset of AMI to CABG were 31 ± 19 and 10 ± 12 days in group P and N, respectively ($p = 0.005$). In group N, 5 of 10 patients underwent the surgery within 1 day after the AMI onset although no patients received the surgery within 1 day in group P ($p = 0.01$). Concomitant procedures were mitral valve replacement in group P, and mitral valve plasty and ventricular septal defect closure in group N. There was no significant difference in OPCAB, distal anastomosis, operation time, use of intra-aortic balloon pumping (IABP) and duration of IABP.

No significant difference was found in hospital stay and complications, intubation period, in-hospital mortality and hospitalization period between group P and N (**Table 6**). No hospital death was observed in both groups P and N. Complications occurred in 30 % of group N although none in P ($p = 0.08$) after surgery. The complications in group N were ventricular tachycardia, respiratory failure and renal failure. Intubation periods were 6.2 ± 5.8 and 3.1 ± 3.8 days in groups N and P, respectively ($p = 0.15$). The hospital stay in group P was 62 ± 20 days and 66 ± 44 days in group N. Intubation periods were 3.1 ± 3.8 and 6.2 ± 5.8 days in groups P and N, respectively.

Discussion

In-hospital mortality was none in patients who underwent CABG for AMI in this study. We did not find a significant difference in the incidence of complication after CABG between the AMI and the non-AMI patients. These results suggest that our treatment strategy for AMI

Table 5

Group	P (PCI + CABG) (n = 12)	N (CABG) (n = 10)		p
Indication for surgery				
Unfavorable anatomy	11	3		
LMT	1	3		
PCI failure		2		
VSP		1		
MR		1		
Onset to CABG	31 ± 19	10 ± 12	days	0.005
CABG within 1 day after AMI onset	0	5 (50)	(%)	0.01
OPCAB	4 (33.3)	3 (30)	(%)	>0.99
Distal anastomosis	2.3 ± 0.9	2.5 ± 1.1		0.55
OP time	309 ± 109	323 ± 73	min	0.73
Use of IABP	6 (50)	8 (80)	(%)	0.2
IABP duration	3.7 ± 3.3	2.5 ± 0.9	days	0.35

CABG, coronary artery bypass grafting; IABP, intra-aortic balloon pumping; LMT, left main trunk; MR, mitral regurgitation; OP, operation; OPCAG, off-pump coronary artery bypass grafting; PCI, percutaneous coronary intervention; VSP, ventricular septal perforation

Table 6

Group	P (PCI+CABG) (n = 12)	N (CABG) (n = 10)		p
Complication after surgery	0	30	%	0.08
Intubation period after surgery	3.1 ± 3.8	6.2 ± 5.8	days	0.15
In hospital mortality	0	0	%	
Hospitalization period	62 ± 20	66 ± 44	days	0.78

CABG, coronary artery bypass grafting; PCI, percutaneous coronary intervention

is reasonable. It is reported that patients who underwent CABG within 2 days of the AMI onset had a higher mortality than 3 and more days after the onset. When patients do not present with an absolute surgical indication, a 3-day waiting period should be considered before CABG.[1, 6] In our study, the time interval from AMI onset to CABG was 10 ± 12 and 31 ± 19 days in patients who underwent only CABG and CABG following PCI, respectively. These long intervals are attributed to the no in-hospital mortality and the equivalent complication incidences to the non-AMI patients. However, the intubation period after surgery and hospitalization period were 4.5 ± 5.0 and 64 ± 32 days, respectively and extremely long compared to the non-AMI patients. Also, the AMI patients received IABP in 63.6 % although the non-AMI patients did only in 16.8 %. The long intubation period and high incidence of IABP use indicate that surgical treatment for AMI is effortful.

The number of patients, who underwent CABG for AMI decreased in the present study compared to the previous studies.[7, 8] We performed 657 CAG for AMI patients, and only 22 (3.3 %) patients required CABG. In the PAMI-2 study, 10.9 % of AMI patients were referred to CABG. The PAMI-2 study was performed from 1993 to 1995[9, 10] before the stent was introduced for AMI treatment. Zielinska et al reported that 4.9 % of AMI patients were qualified for CABG from 2001 to 2003. The stent implantation was performed 61.4 % of patients, who underwent CAG for AMI. In our study, 9 of 12 (75 %) patients received stent implantation. This increased incidence of stent implantation appears to reduce the number of CABG patients for AMI. The primary stenting for AMI had fewer incidences of re-infarction, recurrent, subacute thrombosis and 30-day target vessel revascularization compared to balloon angioplasty.[11] Recurrent ischemia was not observed as the indications for CABG in the present study although it was third major indication for CABG in the PAMI-2 study.[9]

We did not find significant differences in the incidence of complications, intubation period after surgery, in-hospital mortality and hospitalization period between patients who underwent PCI prior to CABG and solo CABG patients. However, no patients required CABG within 1 day from the AMI onset when PCI was performed although half of the patients underwent CABG within 1 day when PCI was not performed. The complication was observed in 30% of group N although none in P ($p = 0.08$). Intubation periods were 6.2 ± 5.8 and 3.1 ± 3.8 days in groups N and P, respectively ($p = 0.15$). These results appear to suggest that PCI prior to CABG is preferable when patients do not have contraindications. There are no reports describing the role of PCI prior to CABG for AMI treatment. Further studies will be warranted to clarify this role.

When the culprit was LMT, all patients received CABG within 1 day after the AMI onset. A drug-eluting stent is now applied to an LMT lesion and demonstrates equivalent mortality and complications to CABG.[12, 13] The number of stent implantations to an LMT lesion for AMI will increase when the risk of re-stenosis is eliminated and would reduce the mortality of emergent CABG, which was reported as 7.9%–14.2 % and 9.8%–19.2 %[2, 6] in previous large studies. It is reported that a drug-eluting stent reduced the re-intervention rate compared to the bare-metal stent. However, in the recent study, the drug-eluting stent showed a higher, late mortality from 6 months to 1 year or 1 year to 2 years than the bare-metal stent.[14, 15] We used a bare-metal stent in all patients who received the stent implantation prior to CABG. Further studies are required to decide which stent is preferable for the initial PCI for our protocol.

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