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Surgical Treatment for Acute Coronary Syndrome : Stabilization by Intra-aortic Balloon Pump

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ABSTRACT

Objectives : Retrospective evaluation on the benefits of preoperative intra-aortic balloon pump (IABP) supplementation was performed in patients with acute coronary syndrome.

Methods : Sixty-seven patients with acute coronary syndrome were included in this study : 50 of these patients had unstable angina pectoris (u-AP) and 17 patients had evolving non-Q acute myocardial infarction (AMI). Of these, 25 with u-AP and 15 with non-Q AMI required IABP insertion because of angina refractory to medical treatment, congestive heart failure, or critical lesions. Seven patients were referred for emergency surgery and the remaining 33 patients, stabilized by IABP support, were scheduled for urgent surgery.

Results : All patients survived surgery. Waiting periods for surgery were 2.5±1.6 days in urgent cases. With one exception, no patients experienced recurrent angina or re-elevation of creatine phosphokinase MB isozyme (CPK-MB) levels. Maximal CPK-MB levels and the ejection fraction after surgery were 92±50 IU/L and 38±18%, respectively, for emergency-surgery patients ($p < 0.01$ vs. others), 57±23 IU/L and 58±14% for urgent-surgery patients, and 54±29 IU/L and 58±15% for elective-surgery patients. The cardiac index was significantly lower before surgery in emergency-surgery patients ($p < 0.05$) but was almost the same at any point after coronary artery bypass graft in other groups. The length of the waiting period did not influence the results.

Conclusion : Preoperative assistance with IABP in acute coronary syndrome is beneficial for relieving angina pectoris, achieving hemodynamic stability, and decreasing the need for emergency surgery. (Jikeikai Med J 2005 ; 52 : 71-7)

Key words : unstable angina, acute coronary syndrome, aortocoronary bypass, intra-aortic balloon pump

INTRODUCTION

Acute coronary syndrome, which includes unstable angina pectoris (u-AP) and non-Q wave acute myocardial infarction (AMI), has shown a rise in the events of myocardial ischemia. Because patients with acute coronary syndrome have higher rates of myocardial infarction and death, the best approach is to perform both pharmacological therapy and aggressive surgical treatment[1-3]. Early revascularization after emergency coronary angiography is recommended because myocardium in the territory of the affected coronary artery is ischemic but viable. A comparison of early, aggressive, invasive treatment (angioplasty or coronary bypass surgery [CABG]) with conservative (pharmacological) treatment showed no difference in survival[4-7]. This lack of benefit can be attributed to the high rate of postoper-

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ative mortality[5].

We perform early revascularization in appropriate patients to prevent adverse outcomes. Because intra-aortic balloon pump (IABP) supplementation augments regional coronary blood flow and decreases oxygen demand in the jeopardized myocardium, we have performed IABP in patients to ensure hemodynamic stability and optimal timing of surgical intervention.

In this study, we retrospectively analyzed surgical results to evaluate the beneficial effect of preoperative IABP supplementation on pharmacological therapy in patients with acute coronary syndrome.

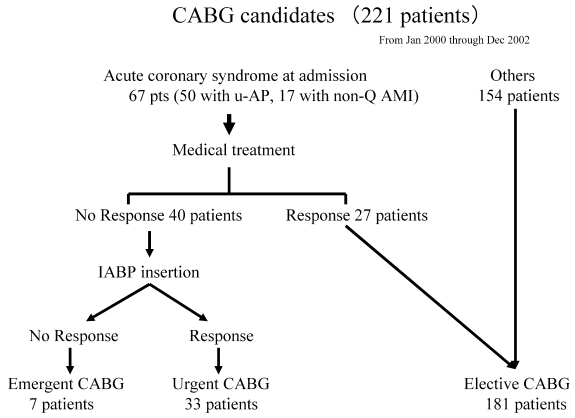

Fig. 1. Selection of operative timing

SUBJECTS AND METHODS

Sixty-seven patients in whom acute coronary syndrome was diagnosed upon emergency arrival at the Saitama Cardiovascular Center and underwent CABG from January 2000 through December 2002 were retrospectively evaluated. Two patients were included in this series after percutanenous transluminal angioplasty (PTCA) performed at our hospital failed. Unstable angina pectoris was diagnosed in 50 of the 67 patients on the basis of the new onset of angina or the aggravation of recent angina. Evolving AMI was diagnosed in 17 of the 67 patients on the basis of levels of the creatine phosphokinase MB isozyme (CPK-MB) 1.5 times higher than the upper limit of normal and the absence of new abnormal Q waves on serial electrocardiography. All patients received optimal pharmacological treatment immediately after diagnosis and underwent emergency coronary angiography. Patients with acute coronary syndrome were selected as candidates for CABG if they had 1) 3-vessel disease, 2) greater than 90% stenosis of the left main trunk (LMT) with or without other diseased coronary arteries, or (3) coronary artery disease associated with congestive heart failure. Six patients required intratracheal intubation before coronary angiography because of respiratory failure. Patients were excluded from the study if they had arrived at the hospital in cardiogenic shock, were operated on because of AMI with abnormal Q waves, or had other coexisting heart diseases. During the study period, elective CABG was performed for 181 patients at the Saitama Cardiovascular Center. Also included in this elective-surgery group were 27 patients who had arrived at the hospital with acute coronary syndrome but were stabilized with pharmacological treatment (Fig. 1). Patients with AMI and Q waves were usually treated with direct PTCA of the affected vessel and treated medically until 3 weeks after the event. Upon being re-evaluated and selected for surgery, they were also included in the elective-surgery group.

Selection of operative timing (Fig. 1)

Before coronary angiography, medical treatment, which consisted of intravenous administration of heparin, nitroglycerin, and a calcium-channel blocker, was started. Chest pain subsided in 27 patients (25 with unstable angina and 2 with non-Q AMI), and elective surgery was usually scheduled for 1 or 2 weeks later.

The remaining 40 patients, 25 with u-AP and 15 with non-Q AMI, required insertion of IABP during or after angiography because of 1 or more of the following reasons: angina refractory to medical treatment (25 patients), congestive heart failure (6 patients), PTCA failure (2 patients), and critical lesions, such as greater than 90% stenosis of the LMT or occlusion of a major artery in multivessel disease (10 patients). Seven patients (5 with u-AP, including 2 in whom PTCA failed, and 2 with non-Q AMI) were referred

for emergency surgery because of critical lesions or hemodynamic instability.

The remaining 33 patients, whose conditions were stabilized with IABP support, were scheduled for urgent surgery. Those requiring urgent CABG were transferred to the cardiac care unit or the intensive care unit, and pharmacological treatment with intravenous injection of nitroglycerin and a calcium-channel blocker was continued. Anticoagulation therapy using heparin was controlled with activating clotting time, approximately 150 seconds, until just before cardiopulmonary bypass was started. Patients with congestive heart failure also received a combination of diuretics, inotropic agents, and a phosphodiesterase III inhibitor. Our protocol was to maintain a stable condition for at least 24 hours after the cardiac event if possible. Secondary factors for deciding the operation date were decreased pulmonary congestion, constant urination, and operating room availability.

Surgical procedures

Two surgeons performed surgeries using similar techniques. CABG was performed with a nonpulsatile or an IABP-induced pulsatile flow of highest possible rate, 2.8 to. 3.0 L/min/m², in normothermia or hypothermia. Patients were monitored with alpha-stat control of arterial blood gases. A cold blood cardioplegic solution was delivered antegradely and retrogradely. Retrograde cardioplegia was performed twice: once immediately after initial antegrade delivery and a second time as a part of terminal warm cardioplegia immediately before the start of antegrade terminal warm cardioplegia. After the completion of each graft anastomosis, antegrade cardioplegia was done with selective delivery to grafts. The pericardial well was soaked with cold saline (without ice) for topical cooling. All proximal and distal anastomoses for CABG were established during single aortic clamping.

Statistical analysis

Data are expressed as means±standard deviation. Frequencies of events and patient characteristics observed among groups were compared with the $\chi 2$ test. Two-way analysis of variance with adjustment for repeated measures was used for intergroup comparison. Calculated significant probabilities were adjusted by Dunnett's multicomparison to control type II error. Analysis of variance with Bonferroni/Dunn multicomparison as a post hoc test was used for intragroup comparison. Differences were considered significant at a p value ≤ 0.05. Statistical analysis was done with the software program SPSS version 6.1 for Macintosh (SPSS Inc., Chicago, IL, USA).

Results

Preoperative and intraoperative data for patients

Table 1. Patients profile

	Elective surgery	Urgent surgery	Emergency surgery	Significance
Number	181	33	7	
Age (years)	64±8	68±10	62±11	ns
Sex (M/F)	143/38	27/6	5/2	ns
DM (%)	61(34)	6(18)**	2(29)	**$p<0.01$ vs. Elective
OMI (%)	111(61)	23(70)	6(86)	ns
CHF (%)	27(15)	8(24)	2(29)	ns
Preop creatinine	0.9±0.3	0.8±0.2	0.9±0.2	ns
LMT>75% (%)	34(19)	7(21)	4(57)*	*$p<0.05$ vs. Elective
Number of Bypasses	2.7±0.9	3.1±0.9	2.4±0.8	ns
ITA use (%)	170(94)	22(68)**	3(43)**	**$p<0.01$ vs. Elective
Patency (%)	97	97	100	ns

DM : Diabetes Mellitus ; OMI : Old Myocardial Infarction ; CHF : Congestive Heart Failure ;
LMT : Left Main Trunk ; ITA : Internal Thoracic Artery ; ns : no significance

Table 2. Cardiac performance

		Preop cath	Postop ICU	ICU 12 hours	ICU 24 hours	Postop catheterization
Emergency ($n=7$)						
Surgery	CI	2.4±0.8*	2.8±0.7	3.1±0.7	3.2±0.9	3.3±1.0
	EF					38±18**
Urgent ($n=33$)						
Surgery	CI	2.6±0.6	2.8±0.6	2.9±0.6	3.0±0.7	3.5±0.7
	EF					58±14
1 day ($n=9$)	CI	2.6±0.3	2.9±0.7	3.1±0.8	3.2±0.5	3.2±0.7
	EF					53±17
≥2 days ($n=24$)	CI	2.6±0.7	2.7±0.5	2.8±0.5	3.0±0.7	3.6±0.8
	EF					60±12
Elective ($n=181$)						
Surgery	CI	3.2±0.9	2.8±0.8	2.9±0.7	3.1±0.8	3.9±1.2
	EF	54±18				58±15

*$p<0.05$ vs. elective surgery, **$p<0.01$ vs. other groups
CI: Cardiac Index; EF: Ejection Fraction; ICU: Intensive Care Unit
1 day: 1-day waiting period; ≥2 days; 2-days or more waiting period in urgent cases

in different surgical timing groups are shown in Table 1. The rate of complications from diabetes mellitus was lower in patients undergoing urgent surgery. The prevalence of LMT lesions in emergent-surgery patients was due to inclusion of 2 LMT dissections during PTCA.

Surgical results

All patients survived emergency surgery or urgent surgery without major complications. The mean waiting period for urgent surgery was 2.5±1.6 days. With one exception, no patients had recurrent angina or re-elevated levels of CPK-MB. One patient with recurrent angina required emergency surgery and was successfully treated. The IABP duration after surgery was similar for emergency-surgery patients (77±17 hours) and urgent-surgery patients (67±56 hours).

A total of 181 patients underwent elective CABG, including 27 initially treated for acute coronary syndrome. Three patients died after surgery because of insufficient cardiac output due to ischemic cardiomyopathy, sudden death on the ward 5 days after surgery, or necrosis of the left lower limb after IABP insertion in the intensive care unit.

Maximum postoperative CPK-MB levels were significantly higher in emergency-surgery patients (92±50 IU/L) than in urgent-surgery patients (57±23 IU/L, $p<0.01$) or elective-surgery patients (54±29 IU/L, $p<0.01$).

Postoperative coronary angiography was performed and evaluated by our cardiologists in most cases. The numbers of anastomoses in bypass, the rate of use of the internal thoracic artery, and the patency rate are shown in Table 1. The internal thoracic artery was used more often in elective surgeries ($p<0.01$), but no differences were observed in graft number or patency.

Cardiac performance

Cardiac indices before and after surgery are shown in Table 2. Preoperative indices in emergency-surgery and urgent-surgery patients are shown after IABP insertion. Left ventricular ejection fraction before and after CABG is also shown in Table 2. The preoperative ejection fractions in emergency-surgery and urgent-surgery patients are omitted because data were not available from all patients.

Preoperative cardiac indices were significantly lower in emergency-surgery patients than in elective-surgery patients. However, the indices after CABG were similar at all time points in all patient groups. In patients undergoing urgent surgery, postoperative indices did not differ significantly between those waiting 1 day for surgery and those waiting 2 days or more. The postoperative ejection fraction was sig-

nificantly lower in emergency-surgery patients than in other patient groups ($p<0.01$) but did not differ between urgent-surgery patients and elective-surgery patients or between urgent-surgery patients waiting 1 day and those waiting 2 days or more.

Discussion

Recent randomized studies of early intervention and conservative treatment for u-AP and non-Q wave AMI have not shown the significance of early intervention but have suggested its possible benefit in decreasing cardiac events[4-7]. These results can be attributed to a higher rate of coronary occlusion in patients undergoing emergency PTCA[6] and higher rates of mortality and morbidity in patients undergoing early CABG[5]. More recently, however, advances in PTCA equipment and in coronary stents have improved outcomes[7].

The efficacy of preoperative IABP has also been established in high-risk patients, in those with low ejection fraction or cardiogenic shock, u-AP, or severe LMT lesions, and for reoperation[8-12]. Preoperative IABP insertion improved cardiac indices, resulting in smaller areas of ischemic myocardium at CABG. Several studies have demonstrated that intraoperative or postoperative IABP insertion generally results in catastrophic outcomes[13,14]. Preoperative IABP remains controversial because of possible vascular complications but can be safety performed by experienced surgeons. Our former policy was to perform emergent CABG in patients with acute coronary syndrome with or without insertion of IABP. However, because of the high rate of operative mortality in the present series, we have adopted a new protocol that seeks to minimize emergency surgeries and to perform urgent surgery after the patient's condition has been stabilized with IABP. Although 7 patients underwent emergency surgery because of hemodynamic instability even after insertion of an IABP, in other patients IABP insertion relieved pain and allowed emergent surgery to be avoided. These patients also showed improvement in congestive heart failure. Elevated or re-elevated CPK-MB levels were not seen during the waiting periods. After the insertion of IABP in urgent-surgery patients, cardiac indices became similar to those in elective-surgery patients and remained nearly constant thereafter. Maximal postoperative CPK-MB levels in urgent-surgery patients were also similar to those in elective-surgery patients, as was the postoperative ejection fraction. Although the trend in cardiac indices was similar after CABG, some results differed in emergency-surgery patients in whom postoperative CPK-MB levels were high and ejection fractions were low. Myocardial damage resulted in preoperative hemodynamic instability, and large areas of jeopardized ischemic myocardium was a cause. To attain better results in emergency-surgery patients, techniques of warm induction, continuous retrograde administration and reperfusion, so-called integrated blood cardioplegia, or on-pump beating surgery should be considered. The time until cardiopulmonary bypass is started should be shortened.

The optimal duration of IABP support before and after surgery has not been established. Previous reports examined the influence of different assist periods (insertion of IABP immediately before, or 2, 12, or 24 hours before surgery) and suggested that longer preoperative IABP treatment results in further improvements in cardiac performance[8,10]. However, there was no difference in the rate of hospital mortality or morbidity. Preoperative support for a mean of 2.5 days in the present study was somewhat longer than in previous reports[8-10]. Because our results suggest that IABP support for 2 days or more did not provide further improvements in postoperative cardiac indices or ejection fraction, support for 24 hours may be sufficient. However, in patients with pulmonary congestion due to deeply depressed left ventricular function, we still prefer to wait 2 or 3 days until chest x-ray films show improvement. Most authors suggest that patients can be weaned from IABP quickly after revascularization, usually within 24 to 36 hours[8-10]. The duration of postoperative support in our series was longer, but this was not related to the patient's cardiac performance but to our policy of routinely requiring a weaning period of 2 to 3 days. We are now reducing the weaning period as we obtain satisfactory outcomes.

Another important issue in the application of preoperative IABP is the number of device-related complications[14,15]. As many researchers have suggested, it is important to identify patients who are at risk for perioperative cardiac events or who may benefit most from perioperative IABP insertion with a minimal risk of complications; otherwise complication rates increase[8-11]. However, the recent development of small catheters and greater surgical experience has led to the low incidence of complications in high-risk patients[8-10], including those of advanced age[11]. In our series no patients undergoing emergency or urgent surgery had complications related to IABP insertion, although the death of 1 patient undergoing elective surgery was related to IABP insertion. Close observation of peripheral circulation and early detection of acute ischemic changes in the limbs are mandatory.

We remain reluctant to use arterial grafts in patients undergoing emergency surgery. Because high CPK-MB levels and low postoperative ejection fractions were observed in patients undergoing emergency surgery, we believe that earlier reperfusion with adequate flow is necessary. The recent preference for use of the internal thoracic artery in urgent operations and several supportive reports[15-17] suggest adopting the use of arterial conduits in patients undergoing emergency surgery.

CONCLUSION

Preoperative IABP assist in patients with acute coronary syndrome refractory to medical treatment was beneficial for relieving angina pectoris and achieving hemodynamic stability. The use of preoperative IABP assist may decrease the need for emergency surgery and reduce operative mortality and morbidity.

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