Prediction of Major Complications after Isolated Coronary Artery Bypass Grafting: The CGMH Experience

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Background: The in-hospital mortality of coronary artery bypass grafting (CABG) is low but can be significant if catastrophic complications occur. To increase the safety of CABG, we aimed to establish a predictive model of major postoperative complications that incorporated patient characteristics and operative strategies.

Methods: A retrospective study was performed which included all consecutive patients receiving isolated CABG from August 2006 to February 2008 (n = 319). Patient characteristics were quantified by the additive EuroSCORE. Operative strategies were classified as cardioplegic arrest, on-pump beating, and off-pump.

Results: Four major complications were identified to be connected to the in-hospital mortality: (1) requirement of mechanical circulatory supports > 72 h (odds ratio [OR] 28.9, 95% confidence interval [CI] 6.0–139.9), (2) requirement of mechanical ventilator supports > 72 h (OR 9.5., 95%, CI 2.2- 42.7), (3) acute renal failure requiring dialysis (OR 9.2, 95% CI 2.2–38.3), (4) major gastrointestinal complications (OR 5.4., 95% CI 1.1–26.7). An increase of additive EuroSCORE (OR 1.2, 95% CI 1.1–1.4) and the cardioplegic strategy (OR 2.7, 95% CI 1.2–6.0) were independent risk factors for major complications. The probability of one or more major complication was >50% for patients receiving cardioplegic CABG with an additive EuroSCORE >8.

Conclusion: Dependence on the mechanical ventilator or circulatory supports >72 h, acute renal failure requiring dialysis, and major gastrointestinal complications were major complications of CABG. The individual risk of having at least one of these complications could be predicted by the patient's preoperative EuroSCORE and operative strategy. A surgical plan tailored by institutional experiences on specific risk factors and aggressive therapeutic plans for major complications are helpful in improving the overall results of CABG.

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Key words: CABG, Off-pump, complications, EuroSCORE, on-pump beating

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In the general population, the in-hospital mortality of coronary artery bypass grafting (CABG) is relatively low, but it increases sharply if serious complications occur.[1] Most of these serious complications are related to the deployment of cardiopulmonary bypass (CPB), which is required in conventional CABG.[2-4] Because patients referred to CABG now tend to be older and sicker than before, the technique of off-pump CABG has been developed to avoid the adverse effects of CPB on these high-risk patients.[5,6] Although off-pump CABG performed by experienced hands shows better short-term and comparable long-term results than conventional CABG,[7] recent meta-analysis of randomized trials that excluded high risk patients revealed that off-pump CABG does not reduce the incidence of postoperative stroke, and a lower graft patency in general practice also occurs.[8-11] Currently, on-pump beating CABG, a trade-off technique of cardioplegic and off-pump CABG, is reported to be an optimal technique to perform CABG in patients with acute myocardial infarction.[12] Because all the CABG strategies (off-pump, on-pump beating, and cardioplegic) have advantages and disadvantages, selecting the optimal strategy for each patient is important. The aim of this study was to predict the probability of major complications among patients receiving isolated CABG with different strategies, by using a retrospective analysis of the preoperative information. These results would be helpful in developing a protocol to improve both safety and long-term efficacy of CABG.

METHODS

Patient characteristics

Between August 2006 and February 2008, a total of 319 patients (236 men and 83 women; mean age, 64 ± 11 years) received isolated CABG in Chang Gung Memorial Hospital (Linkou Medical Center) and were enrolled in this retrospective study. Patients having the minimally invasive direct coronary artery bypass (MIDCAB) were excluded from this study. The study protocol was approved by the institutional review board of our hospital. The CABG techniques used were cardioplegic arrest (n = 99), on-pump beating (n = 132), and off-pump (n = 88). Surgeons were also classified as the high-volume surgeons (performing cardiac surgeries ≥ 50 /year) and the low-volume surgeons (performing cardiac surgeries < 50 /year). The EuroSCORE system was used to perform preoperative risk assessment because of its simplicity and high reliability in the prediction of in-hospital mortality after isolated CABG.[10] The preoperative demographic data, including each patient's EuroSCORE and its variables, were compared among patients receiving different types of CABG.

Outcomes

The primary outcomes of this study were the in-hospital mortality and the occurrence of major complications. Major complications were defined as those who were proven to be independently correlated to the in-hospital mortality. Common postoperative complications were defined as follows: a requirement of prolonged (for more than 72 h) mechanical circulatory supports (MCS) or mechanical ventilators (MV), re-sternotomy for mediastinal hemostasis within 48 h after operation, acute renal failure with a new requirement for renal dialysis (RD) in patients without preoperative renal dialysis, unconsciousness due to new strokes (Glasgow Coma Scale < 11 in intubated patients) documented by image studies, major gastrointestinal complications (symptomatic pancreatitis, ischemic bowel documented by laparotomy, perforated peptic ulcer, or remarkable gastrointestinal bleeding requiring endoscopic intervention), and sternal wound infection requiring muscle flap coverage. The MCS used in this study were intra-aortic balloon pump (IABP) or extracorporeal membrane oxygenator (ECMO). Since patients with MCS are also supported by MV simultaneously in our institute, the requirement of a prolonged MV support was calculated for patients without prolonged MCS.

Anesthesia and surgical techniques

Surgical techniques

A standard anesthesia protocol was used for all patients. Pulmonary artery catheter and transesophageal echocardiography were used for hemodynamic monitoring. Patients received a median sternotomy or a left thoracotomy if a redo CABG was planned. The left internal thoracic artery (ITA) and saphenous vein graft were prepared routinely, unless a total arterial conduits procedure was being considered. In such cases, bilateral ITA and the left radial artery were harvested. The operative strategy for CABG was dependent on the surgeon's preference. The IABP or the ECMO (CAPIOX EBS system, Terumo, Tokyo) was used for patients showing instability before operations or for patients failing to wean off CPB at the end of operations.

Cardioplegic CABG

Before cannulation, systemic heparinization (250 IU/kg) was performed to achieve a target activated clotting time (ACT) of more than 450 seconds(s). The distal ascending aorta (AsAo) and the right atrium (RA) were the usual positions for the establishment of cardiopulmonary bypass (CPB). Occasionally, femoral vessels were used for CPB establishment, especially in cases of re-sternotomy. The left ventricle was consistently vented through the right superior pulmonary vein. Tepid hypothermia (30–28°C) was used to induce ventricular fibrillation, and the aorta was cross-clamped. Myocardial protection was achieved with intermittent antegrade and retrograde cold (4°C) blood cardioplegia every 20 minutes. The cardioplegia was made with a crystalloid cardioplegia (Plegisol; Abbott Laboratories, North Chicago, Illinois) and blood in a blood: cardioplegic ratio of 1:4. Distal anastomoses were constructed first with running sutures of 7-0 polypropylene, and the proximal anastomoses were connected to the ascending aorta with 6-0 polypropylene sutures under a single cross-clamp technique. One liter of warm (37°C) cardioplegia was given retrograde before de-clamping the aorta (hotshot). After patients were weaned from CPB and de-cannulated, the effects of heparin were reversed with protamine.

On-pump beating CABG

Except for the use of aortic cross-clamp, cardioplegia, and hypothermia, the CPB techniques were the same as those for cardioplegic CABG. The proximal anastomoses were created with 6-0 polypropylene sutures under a partial occlusion clamp before aortic cannulation. The AsAo and RA were then cannulated, and distal anastomoses were created with 7-0 polypropylenes on a beating heart with CPB assistance. The left anterior descending coronary artery was revascularized first, followed by the circumflex and right coronary arteries. Regional myocardial immobilization was achieved with a compression stabilizer (CardioThoracic Systems, Inc., Cupertino, CA) or suction stabilizer (Octopus 3; Medtronic, Minnesota; or Estech equipment, Estech-Least Invasive Cardiac Surgery, Danville, CA). A humidified carbon dioxide blower and intra-coronary shunts (Clearview, Medtronic, MN) were used for better visualization during construction of the distal anastomoses.

Off-pump CABG

The sequence and technique of coronary revascularization were the same for on-pump beating and off-pump CABG. For the off-pump group, the initial heparin dose was 150 IU/kg, which was intended to achieve an ACT of about 300 s. The apical vacuum system (Starfish, Medtronic; or Pyramid Positioner, Estech-Least Invasive Cardiac Surgery) was often necessary for revascularization of the posterior or lateral wall vessels. The shed blood was collected from the operating field and re-transfused with an autotransfusion device (COBE BRAT 2, COBE Cardiovascular, Inc., Arvada, CO) to reduce the demand for transfusion.

Outcomes and statistical analysis

Preoperative EuroSCORE variables, operative strategy (cardioplegic arrest, on-pump beating, and off-pump), and common complications were the primary outcomes. The relationships between these variables and in-hospital mortality were investigated. Statistical analysis was performed using SPSS for Windows (Version 15.0, SPSS, Inc., IL). All continuous variables were tested with the Kolmogorov–Smirnov test to check for normal distribution. Comparisons of the continuous variables among groups were performed with the independent *t* test, Mann-Whitney U test, or one-way ANOVA. And comparisons of the categorical variable were performed with the Chi-square test or Fisher's exact test. A receiver operating characteristic (ROC) curve analysis was preformed to determine the discriminative power and the cut-off value of the additive EuroSCORE. Multiple logistic regression was performed to identify the lethal complications after isolated CABG and the impacts of patient characteristics and operative strategies on the occurrence of these major complications.

RESULTS

Operative strategies and preoperative risk

The overall in-hospital mortality was 7% (11% cardioplegic; 7.6% beating; 2% off-pump, p = 0.064.). When compared separately, the only significant difference of in-hospital mortality existed between the off-pump group and the cardioplegic group (2% V.S. 11%; p = 0.018). The mean ($\pm$ SD) and median additive EuroSCORE were 5 ($\pm$ 3) and 4. The mean ($\pm$ SD) and median logistic EuroSCORE were 6.1% ($\pm$ 9.4%) and 2.6%. Both additive and logistic EuroSCORE had good predictive powers in this dataset (area under the ROC curve with 95% C.I.: 0.842; 0.771-0.912 v.s. 0.845; 0.777–0.913, respectively, both $p < 0.0001$). The cutoff point of the additive EuroSCORE was 8 (sensitivity: 61%, specificity: 91%, likelihood ratio: 6.7). Among the 319 operations, 38 were performed by low-volume surgeons and 281 were performed by high-volume surgeons. Surgeons' experiences also contributed to the in-hospital mortality of isolated CABG (high-volume surgeon v.s. Low-volume surgeon: 6.4% v.s. 16%; p = 0.042). Table 1 presents a comparison of the preoperative characteristics, operative parameters, and common postoperative complications among the patients grouped by operative strategy. Patients of the off-pump group had superior short-term outcomes (in-hospital mortality, complication rates, and length of admission), but they had lower preoperative risks than patients in the other groups. To reduce the selection bias, all patients were re-stratified into the high-risk (EuroSCORE > 8) and the low-risk (EuroSCORE $\leq$ 8) groups. Table 2 shows the comparisons of the predicted and observed in-hospital mortalities, operative parameters, and common postoperative complications between the high risk and low risk groups. The high-risk group had a significantly higher incidence of adverse outcomes and requirement of CPB during revascularization.

Major complications

To identify the postoperative complications that were directly related to in-hospital mortality, the relationship between in-hospital mortality and individual postoperative complications was tested by simple logistic regression. Only complications with a $p < 0.05$ were included in the final multiple logistic regression. Four complications were identified as independent risk factors for in-hospital death: a requirement of prolonged MCS (OR = 28.9, p < 0.0001, 95% CI 6.0–139.9), a requirement of prolonged MV support (OR = 9.5, p = 0.03, 95% CI 2.2– 42.7), acute renal failure with a new requirement for RD (OR = 9.2, p = 0.002, 95% CI 2.2–38.3), and major gastrointestinal complications (OR = 5.2, p = 0.04, 95% CI 1.1–26.7). The prediction model comprising these 4 risk factors had a good fit (Hosmer–Lemoshow test, p = 0.79) and a good predictive power (C-index = 0.91, $p < 0.0001$) of the in-hospital mortality. Fig. 1 shows the relationship between the number of major complications and in-hospital mortality. The in-hospital mortality increased sharply among patients with more than one major complication. Because the preoperative characteristics, surgeons' experiences, and the operative strategies were considered to be related to the occurrence of major postoperative complications, the relationship was also analyzed by multiple logistic regression. Both the increase of additive EuroSCORE (OR = 1.2, $p < 0.0001$, 95% CI 1.1–1.4) and the acceptance of cardioplegic CABG (OR = 2.7, p = 0.014, 95% CI 1.2–6.0) were independent risk factors for the occurrence of major complications. However, both the on-pump beating technique (p = 0.29) and the performance of the low-volume surgeons (p = 0.23) did not contribute to major complications independently. The prediction model of major complications showed a good fit (Hosmer–Lemoshow test, p = 0.46) and an acceptable prediction power (C-index = 0.73, $p < 0.0001$) in this dataset. The corresponding possibilities of the occurrence of one or more major complications for each EuroSCORE were calculated by this prediction model and the predicted curve was plotted for each group (Fig. 2). To further reduce the surgeon's bias on the risk of major complications, a new regression model of risk was established for cases operated by the high-volume surgeons and the predicted curve was re-plotted for each group (Fig. 3). Both the increase of additive EuroSCORE (OR = 1.2, p = 0.001, 95% CI 1.1–1.3) and the acceptance of cardioplegic CABG (OR = 3.1, p = 0.008, 95% CI 1.3–7.0) were still the only 2 independent risk factors for the new model. The new model adjusted for surgeons' experiences still had a good fit (Hosmer–Lemoshow

Table 1. Demographic Data of Patients Grouped by Operative Methods

Characteristic	Arrest (n = 99)	Beating (n = 132)	Off-pump (n = 88)	*p* value
Preoperative variables				
Age (year)	64 ± 12	64 ± 11	64 ± 8	0.959
Female (%)	36	25	22	0.054
Diabetes mellitus (%)	48	60	49	0.143
End stage renal failure (%)	8	6	5	0.604
Critical preoperative status (%)	13	5	1	0.003*
Recent myocardial infarction (%)	30	33	23	0.267
Emergency (%)	9	4	0	0.009*
LVEF (%)	53±16	54±17	57±16	0.245
Additive EuroSCORE	6 ± 4	5 ± 3	3 ± 3	< 0.0001*
Predictive mortality (%)	8 ± 12	6 ± 9	4 ± 4	0.001*
Operative variables				
Performing by low-volume surgeon (%)	19	8	10	0.021*
Number of bypass graft	3.4 ± 0.8	3 ± 0.6	3 ± 0.6	< 0.0001*
Complete revascularization (%)	93	90	90	0.539
IABP use (%)	33	25	11	0.002*
ECMO use (%)	7	5	0	0.047*
Aortic clamp time (minutes)	81 ± 31	–	–	–
Total bypass time (minutes)	117 ± 53	94 ± 31	–	–
Postoperative variables				
Days of intensive care	5 ± 5	5 ± 5	3 ± 3	0.003*
Postoperative hospital days	23 ± 30	20 ± 16	13 ± 10	0.003*
In-hospital mortality (%)	11	7.6	2	0.064
Mechanical circulatory support > 72 h† (%)	10	5	0	0.009*
Mechanical ventilation > 72 h (%)	27	14	5	< 0.0001*
Reopen for hemostasis‡ (%)	10	5	2	0.031*
New requirement of dialysis§ (%)	8	8	2	0.189
Major strokeII (%)	5	6	2	0.449
Major gastrointestinal complications¶ (%)	10	5	7	0.373
Sternal wound infection** (%)	3	2	2	0.923

Abbreviations: LVEF: left ventricular ejection fraction; IABP: Intra-aortic balloon pump; ECMO: Extracorporeal membrane oxygenator; *: $p < 0.05$; †: Dependence on IABP or ECMO for > 72 h; ‡: within 48 h after operation; §: occurrence of postoperative acute renal failure with the requirement of renal dialysis in patients without preoperative renal dialysis; II: unconsciousness due to severe brain damage documented by brain computed tomography; ¶: symptomatic pancreatitis, ischemic bowel documented by laparotomy, or severe gastrointestinal bleeding requiring endoscopic intervention; **: requiring surgical debridement and muscle flap coverage.
The post hoc comparison results for significant *p*-values in one-way ANOVA tests:
Additive EuroSCORE: Arrest v.s. Beating ($p = 0.056$); Arrest v.s. Off-pump ($p < 0.0001$); Off-pump v.s. Beating ($p = 0.008$).
Predictive mortality: Arrest v.s. Beating ($p = 0.113$); Arrest v.s. Off-pump ($p = 0.001$); Off-pump v.s. Beating ($p = 0.098$).
Number of bypass graft: Arrest v.s. Beating ($p = 0.002$); Arrest v.s. Off-pump ($p = 0.002$); Off-pump v.s. Beating ($p = 0.919$).
Days of intensive care: Arrest v.s. Beating ($p = 0.847$); Arrest v.s. Off-pump ($p = 0.026$); Off-pump v.s. Beating ($p = 0.003$).
Postoperative hospital days: Arrest v.s. Beating ($p = 0.621$); Arrest v.s. Off-pump ($p = 0.003$); Off-pump v.s. Beating ($p = 0.024$).

Table 2. Comparison of Demographic, Operative, and Postoperative Data of the High-risk Patients (EuroSCORE > 8) and Low-risk Patients (EuroSCORE ≤ 8)

Characteristic	High-risk (n = 41)	Low-risk (n = 278)	*p* value
Additive EuroSCORE	11 ± 2	3 ± 2	< 0.0001*
Predictive mortality (%)	25 ± 16	3.4 ± 3	< 0.0001*
Observed mortality (%)	34	3.2	< 0.0001*
Performing by low-volume Surgeon (%)	46	7	< 0.0001*
Pump assistance (%)	88	70	0.018*
Complete revascularization (%)	86	91	0.399
Number of bypass graft	3 ± 0.8	3 ± 0.7	0.333
Mechanical circulatory support > 72 h (%)	24	2.5	< 0.0001*
Mechanical ventilation > 72 h (%)	54	11	< 0.0001*
Reopen for hemostasis (%)	15	4	0.013*
New requirement for dialysis (%)	29	3	< 0.0001*
Major stroke (%)	10	4	0.24
Major gastrointestinal complications (%)	10	7	0.52
Sternal wound infection (%)	10	1.4	0.011*
Days of intensive care	7 ± 6	4 ± 4	0.003*
Postoperative hospital days	26 ± 26	18 ± 19	0.085*

*: $p < 0.05$.

test, $p = 0.52$) and an acceptable prediction power (C- index = 0.70, $p < 0.0001$).

DISCUSSION

This study described a risk-prediction model for major complications after CABG. Such an investigation could provide useful information for surgeons when choosing the optimal method for patients with different preoperative risks, and improve the quality of postoperative care.[1] In this study, the predicted risks increased in proportion to the patients' additive EuroSCORE. The predicted risks were also significantly higher in the cardioplegic patients than in the non-cardioplegic patients with the same preoperative EuroSCORE. This phenomenon was unchanged when adjusted for the experiences of surgeons, despite the performance of low-volume surgeons increasing the risk of complications within each technique. This finding suggested that the techniques used in cardioplegic CABG (hypothermic CPB, global myocardial ischemia, aortic cross-clamp) might increase the risk of major complications, especially in the high risk patients. The predicted risks in the off-pump group were considered to be the

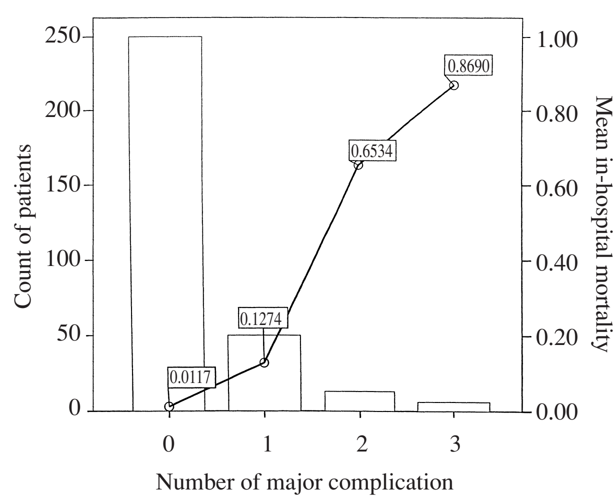

Fig. 1 The relationship between in-hospital mortality and the number of lethal complications.

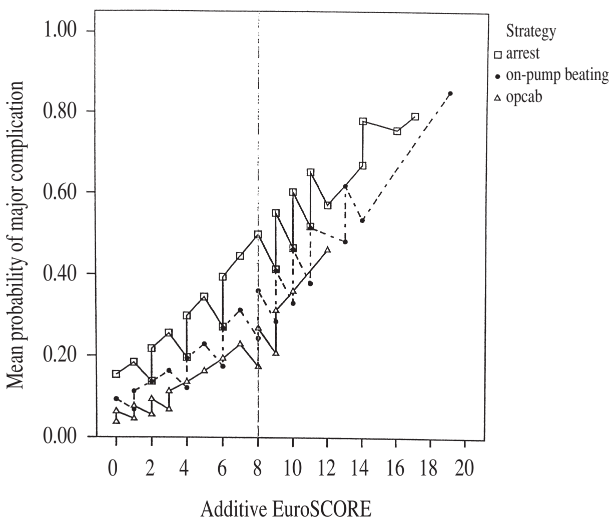

Fig. 2 The predicted risk of occurrence of lethal complications to the additive EuroSCORE in 3 operative strategies. The predicted risks for each additive EuroSCORE were significantly higher in the cardioplegic group when compared to the other 2 groups. The performance of the low-volume surgeon further increased the risk of a specific technique in patients with the same EuroSCORE (Zigzag curves).

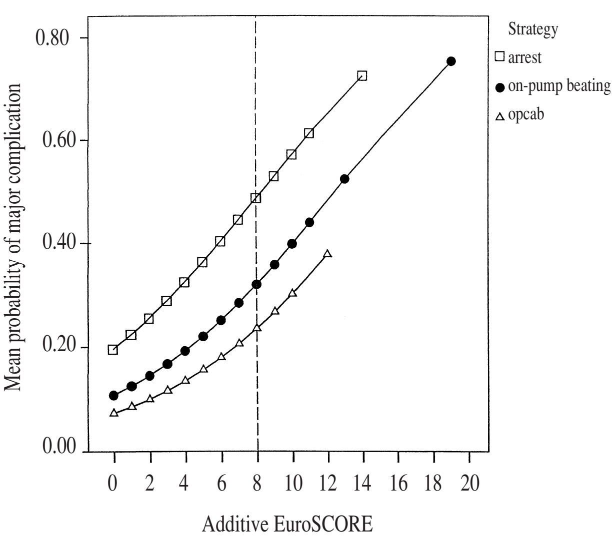

Fig. 3 The predicted risk of the occurrence of lethal complications to the additive EuroSCORE in 3 operative strategies performed by high-volume surgeons. The predicted risks for each additive EuroSCORE were still significantly higher in the cardioplegic group.

"basic" risk for CABG, which included the adverse effects of anesthesia, aortic manipulation, and regional myocardial ischemia during revascularization. A common pitfall of off-pump technique is the occurrence of temporary hypotension during lateral or posterior revascularization. This temporary hypotension often induces symptomatic organ injuries if it persists or occurs frequently during the operation.[13-15] Maintenance of adequate perfusion pressure is a major issue during revascularization, regardless of the operative strategy. Thus, if satisfactory hemodynamics is hard to maintain during revascularization, no hesitation should occur in using a pump. Based on results in this study, the on-pump beating CABG did not increase the risk of major complications significantly when compared to the off-pump technique in patients with a similar EuroSCORE. Thus, in view of reducing major postoperative complications in the patients with a high EuroSCORE (>8), the on-pump beating CABG might be a better substitute than conventional CABG when the off-pump technique is expected to be risky, despite no statistical difference occurring between the two groups in terms of in-hospital mortalities.[13-15]

Four major complications were found to be directly related to the in-hospital mortality in this study. They were the requirement of prolonged MCS or MV support for more than 72 h, acute renal failure with a new requirement for RD, and major gastrointestinal complications. These complications may occur alone or sequentially. Patients often fall into a vicious cycle if the first complication is not addressed properly.[1] In this study, the in-hospital mortality among patients with only one lethal complication was 12.7%, and it increased to 65.3% in patients with 2 of these major complications.

The requirement of a prolonged MV support, without concomitant MCS, was the most common complication (34/319, 10.6% of patients) in this study. It was also the most common complication occurring alone, and was associated with a mortality of 13.6% (3/22). Prolonged intubation after CABG has been reported to be associated with advanced age, intrinsic chronic lung disease, CPB exposure, unconsciousness, renal failure, heart failure, sternal wound infection, and sepsis.[4,16] Patients with prolonged intubation but no other major complication tended to have a higher incidence of major stroke (18% v.s. 3.2%, $p = 0.01$) and a longer CPB time (median 113 v.s. 92, $p = 0.055$) than patients without any major complications in this study. Because a prolonged MV support is often the first major complication, a care plan of negative fluid balance and adequate lung expansion may be helpful for patients receiving pump-assisted CABG. For patients with poor cardiac function or ischemic mitral regurgitation, the application of cardiotonics and after-load reduction agents are also crucial to shorten the supporting days of MV.(4)

The requirement of a prolonged MCS was the most dangerous complication in this study and carried an in-hospital mortality of 47.1% (8/17). As reported previously,(17) this complication was often associated with preoperative critical status and emergent operation. Thirty-five percent (5/14) of the patients supported by ECMO (all were combined with IABP) and all the 3 patients supported by IABP only, expired from impaired heart function or associated multiple organ failure syndrome. Both ECMO and IABP were short-term MCS designed for bridging to recovery. In our experience, the possibility of irreversible heart failure was high if patients failed to wean ECMO beyond an adequate support of 7 days. To prevent multiple organ failure associated with a prolonged use of ECMO, a double-bridge strategy (a ventricular assist device implantation or heart transplant) should be arranged to increase the overall survival of these critical patients.(18,19)

Acute renal failure with new requirements for RD was another critical complication in this study. Renal injuries during CABG may originate from the inflammatory reactions of CPB, or the compromised perfusion status due to low cardiac output at any time.(3,13,16,20) A new requirement for RD is dangerous because it is often a sign of multiple organ dysfunctions. The 20 patients with a new requirement for RD in this study had a mean preoperative creatinine level of 1.9 mg/dl (median 1.7) and a mean additive EuroSCORE of 8.9 (median 10). They also had a mean number of 2.7 (median 3) major complications and an observed in-hospital mortality of 65% (13/20 patients). Compared to the patients with chronic renal failure and dialysis in this study, who had a mean additive EuroSCORE of 5.9 (median 6) and a mortality of 15% (3/20), patients with a new requirement for RD had a higher incidence of preoperative critical status (0% v.s. 38.1%), recent myocardial infarction (30% v.s. 50%), emergent operation (0% v.s. 30%), and pump assistance (80% v.s. 90%). The higher percentage of critical preoperative status, pump dependence, multiple organ injuries, and delayed RD (after failure of high-dose diuretics) may account for the discrepancy in mortality between the two groups. Renal replacement therapy, accompanied with MCS if necessary, should be quickly provided to selected patients to attenuate the adverse effects of electrolyte imbalance and volume-overload on the critical hearts.(21)

Limitations

The study was limited by the small number of enrolled patients and the retrospective design. A further prospective study on the strategy of CABG and the adverse outcomes is necessary to precisely evaluate and validate the impacts of each complication.

Conclusions

A prolonged dependence (> 72 h) on mechanical ventilator or circulatory supports, acute renal failure requiring dialysis, and major gastrointestinal complications were major postoperative complications directly associated with the in-hospital mortality of CABG. The individual risk of having at least one of these major complications could be predicted by one's preoperative EuroSCORE and the strategy of CABG. A delicate surgical plan tailored by institutional experiences on specific risk factors and aggressive therapeutic plans for major postoperative complications may be helpful in persistently improving the overall safety and efficacy of CABG.

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冠狀動脈繞道手術後的致死性併發症之發生與預測：長庚經驗

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背 景： 爲瞭解接受單純冠狀動脈繞道術的病人其術前風險與所接受的手術策略對術後產生的嚴重併發症的影響。

方 法： 對於在2006年8月至2008年2月期間曾於本院接受過單純冠狀動脈繞道術的病人 (共319人) 作一回顧性的臨床研究，病人之術前風險是以歐洲評分系統 (EuroSCORE) 加以量化，而手術的策略則是分爲傳統使用心臟麻痺液的冠狀動脈繞道術，使用體循機輔助的不停跳冠狀動脈繞道術，及不使用體循機輔助的不停跳冠狀動脈繞道術。

結 果： 本研究發現有 4 個常見的術後併發症會直接導致冠狀動脈繞道術後的在院死亡，分別是需要使用呼吸器或機械式循環輔助器大於 72 小時，需要腎臟透析的急性腎衰竭，及嚴重的腸胃道併發症。而病人術前 EuroSCORE 的增加與使用傳統性的使用心臟麻痺液的冠狀動脈繞道術是導致冠狀動脈繞道術後嚴重併發症發生的獨立危險因子。在本研究中，術前 EuroSCORE > 8 的患者接受傳統性的使用心臟麻痺液的冠狀動脈繞道術後產生術後嚴重併發症的機會大於 50%。

結 論： 需要使用呼吸器或機械式循環輔助器大於 72 小時，需要腎臟透析的急性腎衰竭，及嚴重的腸胃道併發症均與冠狀動脈繞道術後之院內死亡有直接相關。個別病人發生一個或一個以上之上述併發症的機率是可以由其術前的 EuroSCORE 與其所接受的手術策略的種類來預估。本研究的結果可提供一套根據本院經驗規劃出的客製化手術計劃與積極的術後併發症監控與治療的方案，循此模式應可持續地增進本院冠狀動脈繞道術的整體安全性與長期效益。
(長庚醫誌 2010;33:370-9)

關鍵詞：冠狀動脈繞道術，不使用體循機之不停跳冠狀動脈繞道術，手術併發症，歐洲評分系統，使用體循機之不停跳冠狀動脈繞道術

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