Current Myocardial Infarction Classification Does Not Predict Risks of Early Revascularization

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Background. **Compared with non-ST-elevation myocardial infarction (MI), ST-elevation MI has been associated with increased mortality after medical treatment and percutaneous coronary intervention. Our study investigated the prognostic value of MI classification in the setting of surgical revascularization within 21 days of MI.**

Methods. **We studied 2412 consecutive patients between 1995 and 2007 who underwent an isolated coronary artery bypass grafting procedure within 21 days after MI. The outcomes of interest were in-hospital mortality and major adverse events, which included death, MI, stroke, and renal failure requiring hemodialysis.**

Results. **Rates of crude in-hospital mortality and major adverse events were higher in ST-elevation MI patients. Stepwise regression analysis suggested that MI subtype (ST-elevation MI vs non-ST-elevation MI) did not predict in-hospital mortality or major adverse events. A secondary analysis using propensity score matching showed similar surgical outcomes between the two cohorts.**

Conclusions. **Surgical risks of patients with recent MI are independent of MI subtype. Distinguishing ST-elevation MI and non-ST-elevation MI is of limited value in the decision-making process of early surgical intervention.**

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As defined by the American College of Cardiology/American Heart Association guidelines [1], acute myocardial infarction (MI) is classified into two subtypes: ST-segment elevation MI (STEMI) and non-ST-segment elevation MI (NSTEMI). The underlying pathophysiology is that the culprit artery in STEMI patients is usually occluded due to acute thrombus formation, whereas the culprit artery in NSTEMI patients is usually patent with a nonocclusive thrombus exposed to the arterial lumen [2]. Given the devastating nature of STEMI, current guidelines recommend a door-to-balloon time of 90 minutes for STEMI patients [3], whereas most NSTEMI patients do not receive similar aggressive treatments in the first few days after the index event [4].

In the setting of unavoidable surgical revascularization during the early course of MI, no consensus has been reached on whether one MI subtype is more risky than the other. If such differences exist, the first question to be addressed is whether this reflects the actual effect of the MI classification. Moreover, is the current MI classification system helpful to triage patients for early surgical revascularization? The contemporary clinical studies comparing surgical outcomes in these two cohorts were not designed to answer these questions. Thus, we sought to analyze the risks of early surgical revascularization, defined as coronary artery bypass grafting (CABG) within 21 days of MI.

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Patients and Methods

The protocol for this study was approved by the Institutional Health Research Ethics Board of the University of Manitoba.

Patients

The computerized database of the University of Manitoba Cardiac Sciences Program was used to identify all patients who underwent CABG within 21 days of MI between March 1995 and March 2007 at two large regional tertiary care centers. Patients included in the final data analysis (1) were aged 18 years and older, (2) underwent isolated CABG, and (3) had an MI within 21 days before CABG. Patients with missing entry for MI subtype were excluded.

Outcomes

The primary end points of this study were in-hospital mortality and in-hospital major adverse events (MAEs), including death, MI, stroke, and acute renal failure requiring hemodialysis. Secondary end points included intensive care unit and hospital length of stay as well as common postoperative complications such as atrial fibrillation, prolonged ventilation (> 24 hours), and reexploration for bleeding.

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Abbreviations and Acronyms

ACC	= aortic cross-clamp
CABG	= coronary artery bypass grafting
CCS	= Canadian Cardiovascular Society
CHF	= congestive heart failure
CI	= confidence interval
COPD	= chronic obstructive pulmonary disease
CPB	= cardiopulmonary bypass
IABP	= intraaortic balloon pump
IMA	= internal mammary artery
LVEF	= left ventricular ejection fraction
MAEs	= major adverse events
MI	= myocardial infarction
NSTEMI	= non-ST-elevation myocardial infarction
NYHA	= New York Heart Association
OR	= odds ratio
PCI	= percutaneous coronary intervention
STEMI	= ST-elevation myocardial infarction
STS	= Society of Thoracic Surgeons

Statistical Analysis

Data are expressed as number and percentages, as mean with standard deviation, or as median with interquartile range (25% to 75%). Continuous variables were compared using the *t* test or the Wilcoxon rank sum test for independent samples, and values of $p < 0.05$ were considered significant. Categoric variables were compared by χ^2 or Fisher exact test as indicated when cell counts were less than 5.

Those variables with $p < 0.20$ on univariable analysis were entered into multivariable models using stepwise logistic regression to yield odds ratios for independent predictors of in-hospital mortality and MAEs. Significance was defined as $p < 0.05$. We used goodness-of-fit tests (Hosmer-Lemeshow test and receiver operating characteristics curves) to evaluate the fitness of final models.

Because it was not possible to randomize our patient population, a secondary analysis using propensity score matching method, described previously [5], was undertaken to account for potential confounding factors and case selection biases. The variables used for developing propensity scores included:

- demographic data, including age, gender, body surface area;
- baseline comorbidities, including hypertension, diabetes, hyperlipidemia, chronic obstructive pulmonary disease, stroke, peripheral vascular disease, and smoking history;
- cardiac history including Canadian Cardiac Society (CCS) angina classification, New York Heart Association (NYHA) classification, left ventricular ejection fraction, history of congestive heart failure (CHF), and left main-stem disease; and
- operative data, including operative urgency, interval between MI and operation, reoperation, and cardiopulmonary bypass time.

A greedy matching procedure selected match pairs initially identical to 5 decimal places of probability [6]. If no match existed at 5 decimal places, matching would occur at 4 decimal places, and so on. If no match existed at 1 decimal place, the patient was excluded from the study. The high matching success was designed to reduce the possibility of introducing systematic biases. Statistical analyses were conducted by using SAS 9.2 software (SAS Institute, Cary, NC).

Results

Patient Population

This study was based on 9387 patients undergoing isolated CABG at the University of Manitoba Cardiac Sciences Program during the 12-year patient accrual period. Of these patients, 2449 had surgical revascularization within 21 days of a MI. We excluded 37 because of missing information on MI subtype. Of the 2412 patients who were then analyzed, 452 had sustained a STEMI and 1960 had sustained a NSTEMI.

Baseline Characteristics

The two cohorts differed substantially with respect to preoperative cardiac conditions (Table 1). The STEMI cohort had a greater proportion of patients with preoperative left ventricle systolic dysfunction (left ventricular ejection fraction < 0.35), cardiogenic shock, and perioperative intraaortic balloon pump insertion. STEMI patients were also more likely to receive thrombolysis or percutaneous coronary intervention preoperatively.

Operative characteristics differed between these two groups in terms of urgency of the procedure as well as timing of revascularization (Table 2). A larger proportion of STEMI patients underwent emergent or salvage procedures. Most STEMI patients underwent CABG within 7 days of the index event. The internal mammary artery was used more frequently in NSTEMI patients, although statistical significance was not achieved. The average cardiopulmonary bypass time of STEMI patients was significantly longer than that of NSTEMI patients, whereas aortic cross-clamp time was similar.

Outcomes

In-hospital outcomes are listed in Table 3. In-hospital mortality of the entire cohort was 4.1% (n = 99). Mortality and incidence of postoperative renal failure, with or without the need of hemodialysis, were significantly higher in the STEMI cohort. Also in this group, the incidence of requiring prolonged ventilation (> 24 hours) postoperatively was twofold that in the NSTEMI cohort. STEMI patients spent more hours in the intensive care unit than NSTEMI patients. There was no difference between groups for perioperative MI, stroke, reexploration for bleeding, or hospital length of stay. The incidence of in-hospital MAEs of the entire cohort was 9.2% (n =