Postoperative Cardiac Troponin I (cTnI) Level and Its Prognostic Value for Patients Undergoing Mitral Valve Surgery

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SUMMARY

It has previously been reported that cardiac troponin I (cTnI) is useful in predicting the postoperative course after cardiac surgery, and that elevated serum cTnI levels are associated with increased in-hospital mortality. However, these findings have been reported in heterogeneous groups of cardiac surgical procedures. In the current study, the usefulness of postoperative cTnI measurements for the prediction of patient outcomes in a specific group of cardiac surgical procedures was determined, with the analysis limited to patients undergoing mitral valve surgery. The results of cTnI measurements were compared with postoperative creatine kinase-myocardial band fraction (CK-MB) levels.

A total of 24 patients who underwent mitral valve surgery from July 2004 to April 2009 were retrospectively studied. Serum cTnI and CK-MB levels were measured on postoperative day (POD) 0 (immediately after surgery), and on POD 1, 2, and 3. The relationship between serum cTnI and CK-MB levels, cardiopulmonary bypass (CPB) time, aorta cross-clamping (AoC) time, and the length of ICU stay and postoperative hospital stay (POHS) were evaluated.

CPB and AoC time influenced postoperative cTnI and CK-MB levels. Values of cTnI on POD 1 and POD 2 were significantly correlated with the length of ICU stay, whereas only the CK-MB level on POD 2 was significantly correlated with the length of ICU stay. In addition, the cTnI levels on POD 1 and POD 2 were significantly correlated with POHS, however, there was no relationship between postoperative CK-MB levels and POHS.

Postoperative cTnI measurements are more useful than CK-MB measurements in predicting the postoperative course of a patient following mitral valve surgery. (Int Heart J 2010; 51: 166-169)

Key words: Troponin I, Creatine kinase-myocardial band fraction (CK-MB), Mitral valve surgery

Cardiac troponin, along with creatine kinase (CK) and its myocardial band fraction (CK-MB), are proteins which are released from damaged cardiomyocytes into the interstitial space. They reach the peripheral circulation either by crossing the walls of myocardial capillaries or by diffusing through the epicardium into the pericardial cavity. Troponin levels are recognized as a sensitive and specific marker for cardiac injury. They are reported to be more accurate than CK-MB levels for the diagnosis of myocardial infarction (MI), and may also provide more useful prognostic information. In particular, serum cardiac troponin I (cTnI) levels are more sensitive than CK-MB levels for detection of minor ischemic myocardial injury in patients with small increases in total CK, and in addition may avoid the high incidence of false positives associated with the use of CK-MB as a diagnostic marker in perioperative MI. Some investigators have reported that cTnI is also useful in predicting the postoperative course after cardiac surgery, and that elevated serum cTnI levels are associated with increased in-hospital mortality. However, these reports included several different types of cardiac surgery, including coronary artery bypass grafting and valve surgery.

Postoperative cTnI measurements may be influenced by the operative method employed, since the magnitude of surgical insult to the myocardium differs in each type of cardiac surgery.

In the current study, changes in postoperative cTnI levels in patients with mitral valve surgery were investigated, and the relationship between postoperative cTnI levels and cardiopulmonary bypass (CPB) time, aorta cross-clamping time, length of stay in an intensive care unit (ICU), and length of postoperative hospital stay (POHS) were evaluated. In addition, the data were compared with postoperative CK-MB levels.

METHODS

Twenty-four patients who underwent mitral valve surgery between July 2004 and April 2009 were included in this series. The mean age was 68 ± 2 (range, 50-83), and there were 11 males and 13 females. The mean preoperative New York Heart Association (NYHA) classification was 2 ± 0.1 (1-4) and mean left ventricular ejection fraction (LVEF)
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All procedures were elective, and the surgical methods used are shown in Table I. A median sternotomy was performed in all operations. Standard CPB was used, and myocardial protection after aortic cross-clamping (AoC) was achieved with blood cardioplegia. There were two reoperations for prosthetic mitral valve failure.

Prior to the study written informed consent was obtained from patients at the time of hospital admission. Serum cTnI and CK-MB were routinely measured after heart surgery along with other laboratory tests conducted by technicians at a laboratory center in our hospital. Serum cTnI levels were measured by the DADE BEHRING Dimension Xpand technique (Dade Behring Inc., Newark, NJ, USA) on postoperative day (POD) 0 (immediately after surgery), and on POD 1, 2, and 3. Serum CK-MB was also measured with spectrophotometric methods at the same intervals. The relationships between serum cTnI and CK-MB levels, CPB time and AoC time were analyzed, and the length of ICU stay (ICUS) and POHS were evaluated.

Statistical analysis: Results are expressed as the mean ± SD. The relationship between cTnI and CK-MB levels, CPB time, AoC time, and length of ICUS and POHS were analyzed by linear regression analysis. StatView software version 5.0 (Abacus, Berkeley, CA, USA) was used for the statistical analysis. Statistical significance was assumed to be present at a \( P \) of less than 0.05.

Results

Duration of operation, CPB, and AoC times were 410 ± 15 (range, 294-545) minutes, 214 ± 13 (range, 131-380) minutes, and 93 ± 7 (range, 81-231) minutes, respectively. There were no operative deaths, but two patients died in hospital on POD 131 and POD 173. The other 22 survivors were discharged from hospital uneventfully. ICUS and POHS were 6 ± 4 (range, 2-23) days and 38 ± 36 (range, 13-168) days, respectively.

Changes in cTnI and CK-MB after mitral valve surgery: The changes in serum cTnI levels after mitral valve surgery are shown in Figure A. The values were similar on POD 0 and 1, and gradually decreased thereafter. Figure B shows the changes in CK-MB levels after mitral valve surgery. CK-MB gradually decreased after POD 0, and the CK-MB level on POD 3 was less than 20% of that on POD 0.

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cTnI and CK-MB levels, and was significantly correlated with both cTnI and CK-MB on POD 0, 1, and 2 (Table II). **Relationship between serum levels of cTnI and CK-MB versus length of ICU and POHS**: Serum cTnI on POD 1 and 2 were significantly correlated with the length of ICU (Table III). However, only CK-MB on POD 2 was significantly correlated with the length of ICU (Table III). In addition, cTnI on POD 1 and 2 were significantly correlated with the length of POHS. On the other hand, there was no correlation between postoperative CK-MB levels and the length of POHS (Table III).

**DISCUSSION**

It has been previously reported that cTnI is useful in predicting postoperative cardiac events and prognosis after cardiac surgery.\(^8\)\(^{-10}\) However, these studies dealt with patients who underwent a variety of surgical procedures, including coronary artery bypass grafting (CABG)\(^9\)\(^{-10}\), as well as valve surgery including both aortic and mitral valve procedures.\(^11\) Accordingly, the nature of the cardiac surgery among these studies differed considerably. In the current study we investigated the usefulness of postoperative serum cTnI measurements in a group of patients having mitral valve surgery, all of whom were managed in a uniform and consistent manner, and compared the results with serum CK-MB levels. This focus on serial postoperative changes in serum cTnI is noteworthy, since there have been few other reports that provided such continuous measurements postoperatively.

We noted that CPB time and AoC time influenced both cTnI and CK-MB levels, and both measurements also correlated with the length of ICUS. In addition, serum levels of cTnI correlated with the length of POHS, but there was no such relationship between CK-MB levels and the length of POHS. Two patients died in hospital within 6 months of the surgery. One was an 83-year-old male with severe mitral and tricuspid regurgitation who had required hemodialysis (3 times a week) due to chronic renal failure for 12 years. His preoperative NYHA classification and LVEF was 3 and 60%, respectively, and unstable hemodynamics was frequently found during hemodialysis preoperatively. He successfully underwent mitral valve replacement and maze operation. However, a postoperative cerebral infarction occurred, and multiple organ failure syndrome due to sepsis based on pneumonia (Pseudomonas aeruginosa) was uncontrollable and he died on POD 173. Another patient was a 75-year-old male with severe mitral regurgitation, and he also had required hemodialysis (3 times a week) due to chronic renal failure for 12 years. His preoperative NYHA classification and LVEF was 3 and 60%, respectively, and unstable hemodynamics was frequently found during hemodialysis preoperatively. He successfully underwent mitral valve replacement and maze operation. However, a postoperative cerebral infarction occurred, and multiple organ failure syndrome due to sepsis based on pneumonia (Pseudomonas aeruginosa) was uncontrollable and he died on POD 131. The other 22 patients had uneventful recoveries and were discharged from hospital.

Fellahi and coworkers reported that a high postoperative peak of cTnI was associated with increased risk of death, death from cardiac causes, and nonfatal cardiac events within two years following CABG.\(^11\) Relos and colleagues indicated that moderate elevations of serum cTnI might reflect ongoing myocardial injury in the critically ill, and were associated with a higher mortality rate and longer hospital and ICU lengths of stay.\(^12\) Cardiac troponins are the structural proteins of the myocardium. They are distributed to a soluble fraction in the cytoplasm, and also to a larger share that exists as a component of the structural protein of myofibrils. CK-MB is present in the soluble fraction in the cytoplasm. The release kinetics of cardiac troponins reflect two types of myocardial injury, either due to loss of the integrity of the cell membrane, or to progressive irreversible necrosis of myofibrils.\(^13\) A slight elevation of cardiac troponin levels may represent reversible injury, however, a substantial rise signifies the presence of myocardial cell necrosis and irreversibility.\(^14\) These distinctive features may contribute to the increased utility of cardiac troponin measurements over CK-MB in postoperative course prediction.

Our study has some limitations. The sample size was small and the observational period was short. A larger number of patients and a long-term observational period are necessary to evaluate the value of cTnI as a useful predictor concerning the prognosis after mitral valve surgery.

In conclusion, after mitral valve surgery, postoperative cTnI and CK-MB levels are significantly correlated with CPB time and AoC time. However, serum cTnI levels appear to be more useful than CK-MB levels for predicting the postoperative course, including the length of hospitalization.

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**Table III. Serum Levels of cTnI and CK-MB Versus Length of ICU Stay and POHS**

<table>
<thead>
<tr>
<th>Correlation coefficient</th>
<th>Length of ICU stay</th>
<th>Length of POHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>cTnI POD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0.240</td>
<td>0.260</td>
</tr>
<tr>
<td>1</td>
<td>0.646</td>
<td>0.454</td>
</tr>
<tr>
<td>2</td>
<td>0.761</td>
<td>0.483</td>
</tr>
<tr>
<td>3</td>
<td>0.054</td>
<td>0.266</td>
</tr>
<tr>
<td>CK-MB POD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0.098</td>
<td>0.037</td>
</tr>
<tr>
<td>1</td>
<td>0.326</td>
<td>0.228</td>
</tr>
<tr>
<td>2</td>
<td>0.618</td>
<td>0.472</td>
</tr>
<tr>
<td>3</td>
<td>0.395</td>
<td>0.382</td>
</tr>
</tbody>
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POHS indicates postoperative hospital stay. \(^*P < 0.05.\)
REFERENCES


