History of Heart Failure is the Major Risk Factor in Coronary Patients Undergoing Abdominal Nonvascular Surgery

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Citation

Abstract
Background: Patients with a history of heart failure who undergo noncardiac surgery under general anesthesia are at increased risk of perioperative cardiac complications. Methods: Our prospective observational clinical study included 111 consecutive patients with angiographically verified coronary artery disease, undergoing open abdominal nonvascular surgery under general anesthesia. They were divided into two stratification subgroups, subgroup I-with a history of heart failure 17/111 (15.3%) vs subgroup II-without a history of heart failure 94/111 (84.7%), and compared in relation to the incidence of expected perioperative cardiac complications. Results: The incidence of perioperative heart failure as well as the incidence of all expected perioperative cardiac complications was significantly higher in coronary patients with a history of heart failure (p<.01). Conclusions: We proved that history of heart failure was the major risk factor of perioperative heart failure and all expected perioperative cardiac complications in coronary patients undergoing open abdominal nonvascular surgery under general anesthesia.

INTRODUCTION
Cardiac patients have significantly more major and fatal perioperative cardiac complications compared with noncardiac patients undergoing similar type of surgical operation and anesthesia. Out of a total number of perioperative mortal outcome of cardiac patients in noncardiac surgery, over 50% was of cardiac etiology. Out of all types of noncardiac surgical interventions, major abdominal and thoracoabdominal surgery is the highest stress to cardiovascular system. Coronary patients with the history of heart failure are at significant risk of perioperative major cardiac complications (acute myocardial infarction, acute pulmonary edema, malignant arrhythmias, cardiac arrest and cardiac death). Postoperative cardiogenic pulmonary edema develops in about 2% of patients without earlier congestive heart failure, in about 6% of patients with former well controlled heart failure and in about 16% of patients with the acute heart insufficiency in the immediate postoperative period.

The aims of our prospective observational clinical study were:

- to prove that a history of heart failure in coronary patients is the major risk factor for perioperative heart failure;
- to prove that a history of heart failure in coronary patients is the major risk factor for all expected perioperative cardiac complications.

MATERIAL AND METHODS
STUDY PROTOCOL
Our prospective observational clinical study included 111 consecutive patients with angiographically verified coronary artery disease, operated on at the Clinic of Digestive Surgery, University Clinical Center of Serbia, (tertiary level-teaching hospital), Belgrade, Serbia. Risk assessment and preoperative preparation were carried out in the line with the American College of Cardiology/American Heart Association (ACC/AHA) guidelines published in 2002.
Immediately upon admission, all patients underwent medical-cardiological examination which included the history, physical status, electrocardiogram (Schiller AT-1, Schiller Corp, Austria), X-ray of the lungs and heart (Shimadzu RS 50 A, Shimadzu Corp, Kyoto, Japan), and complete laboratory tests (Olympus 400, Olympus, Tokyo, Japan). Preoperatively, all of them were subjected to transthoracic echocardiography (Siemens Sequoia 256, Siemens Corp, Mountain View, CA) for evaluation of size and function of the left ventricle.

Criterion to be enrolled in the study was angiographically verified coronary arterial disease.

All patients from the selected group underwent coronary angiography in preoperative, prehospital period, independently of noncardiac surgery along with cardiosurgical consultation decision on further treatment of coronary disease – myocardial revascularization (coronary artery bypass grafting) or drug therapy (beta-blocker, aspirin, statin). Angiographically verified severe stenosis of coronary arteries (greater or equal than 75% blood vessel stenosis) with indication for myocardial revascularization was found in 7/17 (41.2%) patients with a history of heart failure, and 48/94 (51.2%) patients without a history of heart failure. Mild stenosis of coronary arteries (less than 75% blood vessel stenosis) with recommendation for drug therapy was detected in 10/17 (58.8%) patients with a history of heart failure, and 46/94 (48.9%) patients without a history of heart failure. The group of consecutive patients without coronary angiography was excluded from the study, because their coronary disease was diagnosed only on the basis of medical history, without any former diagnostic tests.

The history of heart failure was based on review of medical documentation dated from perioperative period. Heart failure was diagnosed according to “Framingham Criteria for Heart Failure.”

**PERIOPERATIVE MANAGEMENT - RISK REDUCTION STRATEGY**

Perioperative monitoring and drug therapy were carried out in the line with the American College of Cardiology/American Heart Association (ACC/AHA) guidelines published in 2002.

The patients were monitored by continuous electrocardiogram during the surgery as well as in the immediate postoperative 72-hour period in the Intensive Care Unit, which recorded blood pressure and heart rate values every hour, all kinds of ECG changes as well as saturation. Electrocardiography was performed immediately after surgery, on postoperative days 1, 2, 7 and one day before discharge from hospital. Cardiac biomarkers (CKMB and Troponin) were evaluated at 6 h, 24 h and 96 hours following the surgery according to ACC/AHA 2002 recommendations. All patients were monitored on daily basis during their stay in hospital and upon discharge until postoperative day 30. During hospitalization, all patients were observed by cardiologist every day.

Myocardial revascularization prior to open abdominal nonvascular surgery was performed in 2 (11.8%) patients with a history of heart failure and in 32 (34.0%) patients without a history of heart failure. Indicated revascularization was not carried out in 15 (88.2%) patients with a history of heart failure, because of urgent surgery and/or poor general health condition.

Perioperative beta blocker therapy was applied in 10 (58.8%) coronary patients with a history of heart failure, and in 73 (77.6%) coronary patients without a history of heart failure.

**PERIOPERATIVE CARDIAC COMPLICATIONS**

The following perioperative cardiac complications were considered:

**MINOR PERIOPERATIVE CARDIAC COMPLICATIONS**

Hypertension (BP>160/100 mmHg, Class II JNC VII)- according to criteria of the Joint National Committee;

Newly developed benign cardiac arrhythmias and conduction disturbances (sinus tachycardia HR>100bpm, supraventricular tachyarrhythmias, atrial fibrillation with rapid ventricular response, isolated premature ventricular contractions, nonsustained ventricular tachycardia, newly developed block of the branch right/left and AV block I and II)-documented by 12-lead electrocardiography and/or Holter electrocardiography.

Transient myocardial ischemia with or without chest pain (transient and/or repeating ST ≥ 2mm in leads V1,V2,V3, ≥ 1 mm in the other leads, ST ≥ 1 mm in at least 2 adjoining leads, and/or symmetric inversion T waves ≥ 1 mm);
**COMPLICATIONS**

Newly developed malignant cardiac arrhythmias and conduction disturbances (sustained ventricular tachycardia, ventricular fibrillation, and AV block III°) - documented by 12-lead electrocardiography and/or Holter electrocardiography;

Diagnosis of newly developed cardiac benign/malignant arrhythmias was made by comparison of preoperative, and intra-/postoperative 12-lead electrocardiography and/or Holter electrocardiography;

Acute myocardial infarction (ESC/ACC 2000);  
Heart failure - according to “Framingham Criteria for Heart Failure.”

Cardiac arrest;

Cardiac death to the 30\textsuperscript{th} postoperative day.

**STATISTICAL ANALYSIS**

Coronary patients were divided into two stratification subgroups in relation to history of heart failure.

Subgroup I included patients with a history of heart failure – 17/111 (15.3%) and subgroup II consisted of patients without any history of heart failure - 94/111 (84.7%).

Both groups of patients were compared in relation to minor, major and fatal perioperative cardiac complications.

Statistical design was presented by Pearson’s $\chi^2$ test and binomial logistic regression.

Pearson’s $\chi^2$ test was used in the form of contingency tables, given that variables were of attributive categorical type and significance level was at border-line of 0.05.

Binomial (or binary) logistic regression is a form of regression which is used when the dependent is a dichotomy and the independents are of any type. Logistic regression can be used to predict a dependent variable on the basis of continuous and/or categorical independents and to determine the percent of variance in the dependent variable explained by the independents; to rank the relative importance of independents; to assess interaction effects; and to understand the impact of covariate control variables.

**RESULTS**

Using the Pearson’s $\chi^2$ test we found:

A total number of patients with perioperative cardiac complications in both stratification groups was 66/111 (59.5%), and 45/111 (40.5%) patients had no cardiac complications. A total number of perioperative cardiac complications was 132. The most common cardiac complication was hypertension (42.3%) 47/111, and the least frequent was myocardial infarction (4.5%) 5/111. A number of patients with lethal outcome of cardiac origin until 30\textsuperscript{th} postoperative day was 3/111 (2.7%).

Table 1 presents the clinical characteristics of selected coronary patients according to history of heart failure.

**Figure 1**

Table 1: Clinical characteristics of selected coronary patients according to history of heart failure.
Table 2: Echocardiographic parameters of selected coronary patients according to history of heart failure

<table>
<thead>
<tr>
<th>Echocardiographic parameters of selected coronary patients</th>
<th>History of HF</th>
<th>Without history of HF</th>
<th>Total number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>End-diastolic diameter of the left ventricle &gt;5.7 cm</td>
<td>12 (70.0%)</td>
<td>9 (9.0%)</td>
<td>45 (40.5%)</td>
</tr>
<tr>
<td>Left ventricular ejection fraction &lt;55%</td>
<td>6 (33.3%)</td>
<td>9 (9.0%)</td>
<td>15 (13.5%)</td>
</tr>
<tr>
<td>Segmental wall motion abnormalities</td>
<td>14 (82.0%)</td>
<td>16 (48.6%)</td>
<td>40 (54.0%)</td>
</tr>
</tbody>
</table>

Table 3 shows the type of surgery and nature of digestive illness of selected coronary patients according to history of heart failure.

Table 3: Type of surgery and nature of digestive illness of selected coronary patients according to history of heart failure

<table>
<thead>
<tr>
<th>Type of surgery and nature of digestive illness of selected coronary patients</th>
<th>History of HF</th>
<th>Without history of HF</th>
<th>Total number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergent surgery</td>
<td>3 (17.0%)</td>
<td>24 (25.5%)</td>
<td>31 (27.9%)</td>
</tr>
<tr>
<td>Elective surgery</td>
<td>14 (82.0%)</td>
<td>66 (70.5%)</td>
<td>80 (72.1%)</td>
</tr>
<tr>
<td>Nature of digestive illness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malignant disease of digestive system</td>
<td>9 (47.1%)</td>
<td>44 (46.8%)</td>
<td>53 (60.8%)</td>
</tr>
<tr>
<td>Benign disease of digestive system</td>
<td>9 (52.9%)</td>
<td>50 (53.2%)</td>
<td>59 (63.2%)</td>
</tr>
<tr>
<td>Esophageal surgery</td>
<td>2 (11.1%)</td>
<td>9 (9.0%)</td>
<td>11 (10.0%)</td>
</tr>
<tr>
<td>Hepatobiliary surgery</td>
<td>6 (32.5%)</td>
<td>4 (4.1%)</td>
<td>10 (9.0%)</td>
</tr>
<tr>
<td>Colorectal surgery</td>
<td>16 (88.9%)</td>
<td>2 (2.1%)</td>
<td>18 (16.1%)</td>
</tr>
<tr>
<td>Vascular hemia repair</td>
<td>6 (20.7%)</td>
<td>11 (11.7%)</td>
<td>17 (15.3%)</td>
</tr>
</tbody>
</table>

Table 4 presents drug therapy of selected coronary patients according to history of heart failure.

Table 4: Drug therapy of selected coronary patients according to history of heart failure

The main result of our prospective observational clinical study was: highly significant difference between two studied subgroups of coronary patients with the history of heart failure vs without the history of heart failure, in relation to incidence of perioperative heart failure 6/17 (35.3%) vs 0/94 (0.0%) (p<0.01).

Our study also found highly significant difference in relation to incidence of:

- newly developed arrhythmias and conduction disturbances (benign and malignant) (p<0.05),
- transient myocardial ischemia (p<0.01),
- acute myocardial infarction (p<0.01),
- number of patients with major cardiac complications (p<0.01),
- a total number of patients with minor, major and fatal of cardiac complications (p<0.01) and
- number of patients assisted by mechanical ventilation (p<0.01).

It failed to prove statistically significant difference in relation to incidence of perioperative hypertension and cardiac death till postoperative day 30, but it established that the percentage of these perioperative cardiac complications was higher in patients with the history of heart failure. (see Table 5)
History of Heart Failure is the Major Risk Factor in Coronary Patients Undergoing Abdominal Nonvascular Surgery

Figure 5
Table 5: Comparison of selected patients with or without history of heart failure in relation to the incidence of perioperative cardiac complications

<table>
<thead>
<tr>
<th>Perioperative cardiac complications</th>
<th>With a history of heart failure</th>
<th>Without a history of heart failure</th>
<th>Total number of cardiac complications</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>n=17 (18.3%)</td>
<td>n=40 (84.1%)</td>
<td>n=57 (100%)</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>BP &gt; 160/100 mmHg</td>
<td>9 (52.9%)</td>
<td>28 (40.0%)</td>
<td>37 (42.3%)</td>
<td></td>
</tr>
<tr>
<td>Newly developed arrhythmias and conduction disturbances (design malignant)</td>
<td>6 (35.3%)</td>
<td>13 (18.3%)</td>
<td>19 (17.3%)</td>
<td></td>
</tr>
<tr>
<td>Transient myocardial ischemia</td>
<td>8 (47.0%)</td>
<td>17 (24.6%)</td>
<td>25 (22.2%)</td>
<td></td>
</tr>
<tr>
<td>Acute myocardial infarction</td>
<td>3 (17.6%)</td>
<td>2 (2.9%)</td>
<td>5 (4.5%)</td>
<td></td>
</tr>
<tr>
<td>ACC/ESC 2000</td>
<td>17 (18.8%)</td>
<td>5 (7.3%)</td>
<td>22 (20.0%)</td>
<td></td>
</tr>
<tr>
<td>Perioperative heart failure</td>
<td>6 (35.3%)</td>
<td>0 (0.0%)</td>
<td>6 (5.4%)</td>
<td></td>
</tr>
<tr>
<td>Cardiac death until 30th postoperative day</td>
<td>1 (5.9%)</td>
<td>2 (2.9%)</td>
<td>3 (2.7%)</td>
<td></td>
</tr>
<tr>
<td>Total number of patients with cardiac complications</td>
<td>15 (88.2%)</td>
<td>51 (72.2%)</td>
<td>66 (59.3%)</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Number of patients with major cardiac complications</td>
<td>6 (35.3%)</td>
<td>4 (6.2%)</td>
<td>10 (9.0%)</td>
<td></td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>5 (29.4%)</td>
<td>4 (5.9%)</td>
<td>9 (8.1%)</td>
<td></td>
</tr>
</tbody>
</table>

Using the univariate logistic regression analysis we proved that risk factors for perioperative heart failure were valvular heart diseases, history of renal failure chronic/acute, chronic obstructive pulmonary disease, left ventricular ejection fraction < 35%, segmental wall motion abnormalities and poor gas analyses. (see Table 6)

Figure 6
Table 6 Results of logistic regression analysis

Using the multivariate logistic regression analysis we didn’t prove that any one of this evaluated parameters was an independent predictor of perioperative cardiac complications. (see Table 6)

DISCUSSION

Our prospective observational clinical study analyzed perioperative cardiac complications in coronary patients with vs without a history of heart failure undergoing open abdominal nonvascular surgery under general anesthesia.

Risk assessment, preoperative preparation, postoperative monitoring and perioperative drug therapy were carried out in the line with the American College of Cardiology/American Heart Association (ACC/AHA) guidelines published in 2002. 3

The study verified that the incidence of all expected perioperative cardiac complications was significantly higher
in patients with the history of heart failure.

All six patients who developed perioperative heart failure belonged to the group with the history of heart failure.

The study failed to prove significant difference of incidence of fatal complications between two studied groups, but mortality rate of cardiac etiology was higher in the group of patients with the history of heart failure.

We proved that risk factors for perioperative heart failure were valvular heart diseases, history of renal failure chronic/acute, chronic obstructive pulmonary disease, left ventricular ejection fraction < 35%, segmental wall motion abnormalities and poor gas analyses.

We didn’t prove that any one of these evaluated parameters was an independent predictor of perioperative cardiac complications.

Direct causes of death in all three patients were the acute heart failure, acute myocardial infarction and newly developed malignant arrhythmias (ventricular tachycardia and ventricular fibrillation). One patient died on day 2, and other two on postoperative day 3. Cardiac cause of death was confirmed by postmortem examination.

One very large study involving 23,340 patients having undergone major noncardiac surgery compared the operative mortality in three groups of patients till 30th postoperative day. The first group included patients with coronary artery disease without a history of heart failure, group II included patients with a history of heart failure without coronary artery disease and group III consisted of patients with neither history of heart failure nor coronary artery disease. Mortality in group I was 6.6%, in group II was 11.7%, and in group III was 6.2%.

One new study evaluated 557 consecutive patients with heart failure (192 EF less than or equal to 40% and 365 EF greater than 40%) and 10,583 controls who underwent major elective noncardiac surgery. Patients with clinically stable heart failure did not have high perioperative mortality rates in association with elective major noncardiac surgery, but they were more likely than patients without heart failure to have longer hospital stays, were more likely to require hospital readmission, and had a substantial long-term mortality rate.

The latest and the largest study to date presented 159,327 major noncardiac surgery procedures, 18% were performed in patients with heart failure and 34% were performed in patients with coronary artery disease. Adjusted hazard ratios of mortality for patients with heart failure, compared with patients with neither heart failure nor coronary artery disease, were 1.63 (95% confidence interval, 1.52-1.74) and 1.51 (95% confidence interval, 1.45-1.58), respectively. Adjusted hazard ratios of mortality for patients with coronary artery disease, compared with patients with neither heart failure nor coronary artery disease, were 1.08 (95% confidence interval, 1.01-1.16) and 1.16 (95% confidence interval, 1.12-1.20), respectively.

Two large studies proved that patients with heart failure were at significantly higher risk for adverse outcomes compared with other patients admitted for the same procedures.

CONCLUSIONS

Our study verified as follows:

history of heart failure in coronary patients undergoing open abdominal nonvascular surgery under general anesthesia was the major risk factor for perioperative heart failure (p<0.01);

history of heart failure in coronary patients undergoing open abdominal nonvascular surgery under general anesthesia was the major risk factor for all expected perioperative cardiac complications (p<0.01).

References

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