

Myocardial infarction in patients undergoing noncardiac surgery¹

Richard C. Becker, M.D.²
Donald A. Underwood, M.D.

Coronary artery disease is the leading cause of death in the United States and other industrialized nations. Patients with coronary artery disease are at high risk for myocardial infarction following noncardiac surgery. The authors identify 28 such patients with a 43% mortality rate. Ninety-three percent of infarctions occurred within the first two postoperative days. Chest pain was the presenting symptom in only 39% of these patients. Other presenting signs and symptoms included hypotension, heart failure, alteration of mental status, various atrial and ventricular arrhythmias, and cardiac tamponade from ventricular rupture. Advanced age and identified coronary atherosclerosis seemed to be dominant risk factors.

Index terms: Myocardial infarction · Surgery, operative, adverse effects

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Despite the decrease in overall cardiovascular mortality,¹ myocardial infarction remains the leading cause of death in industrialized nations; more than 500,000 deaths occur annually in the United States alone.²

The risk of sustaining a myocardial infarction following a major surgical procedure is small,³ except in patients with coronary artery disease.³⁻⁶ Thus, the physician's ability to identify patients at increased risk is a vital component of the preoperative medical evaluation. Many studies have identified preoperative factors which predict postoperative or perioperative cardiac complications in general surgical populations.^{7,8} This review presents our experience with patients sustaining myocardial infarction following noncardiac surgery.

¹ Departments of Internal Medicine (R.C.B.) and Cardiology (D.A.U.), The Cleveland Clinic Foundation. Submitted for publication Apr 1986; accepted Aug 1986.

² Current location: Department of Cardiology, University of Massachusetts, Worcester.

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Table 1. Timing of myocardial infarction following surgery

Postoperative day	Number of patients (percent)
0	11 (39%)
1	6 (21%)
2	9 (32%)
3	0
4	1 (4%)
5	0
6	0
7	1 (4%)

Materials and methods

Discharge information for all patients undergoing major elective or emergent noncardiac surgery between November 1, 1980, and September 1, 1984, was reviewed to determine if a coded in-hospital myocardial infarction had occurred. These records were evaluated to ensure that adequate evidence of myocardial infarction existed. Myocardial infarction was defined as a new transmural infarct based on evolution of pathologic Q waves on the electrocardiogram and persistent ST and T wave changes associated with characteristic serum enzyme changes or an appropriate clinical picture of pain, congestive heart failure, or arrhythmia. Twenty-eight patients met the criteria.

Following the confirmation of perioperative myocardial infarction, the following information was obtained: age, sex, type and duration of surgery, type of anesthesia, presence of intraoperative hypotension, evidence of coronary artery disease (previous myocardial infarction, past coronary artery bypass graft surgery, abnormal coronary arteriography, or angina pectoris), and traditional cardiac risk factors (heavy cigarette use, diabetes mellitus, hypertension, and hypercholesterolemia). The patient's preoperative electrocardiogram was reviewed for evidence of past myocardial infarction, abnormal ST and T wave appearance, and ventricular ectopy. The preoperative chest radiograph was evaluated for the presence of aortic calcification.

The postoperative course was reviewed for timing of myocardial infarction, clinical presentation, complications after the myocardial infarction, and the ultimate clinical outcome. Congestive heart failure was considered to have occurred if the patient was found to have pulmonary rales, a third heart sound, and a chest radi-

ograph supporting such findings. Determination of arrhythmias required a diagnostic electrocardiogram with rhythm strip. A cardiac death was defined as death from an arrhythmia or refractory low-output cardiac state. A noncardiac death was defined as death from any other cause regardless of the presence of cardiac complications.

Results

There were 30,000 potential subjects undergoing major noncardiac surgical procedures over the period of study. Records of 28 individuals (71% male) who sustained an identified perioperative myocardial infarction were found. The ages ranged from 48 to 93 years (average, 71 years). Twenty-five (89%) had an abnormal electrocardiogram—14 (50%) with findings compatible with a previous myocardial infarction. By history, 18 (64%) had stable angina pectoris, 17 (61%) had hypertension, 14 (50%) used tobacco on a daily basis (>1 pack/day for at least five years), and 8 (29%) had insulin-treated diabetes mellitus. Cholesterol levels ranged from 126 mg% to 310 mg% (average value, 186 mg%). Fifteen (54%) had aortic calcification as shown on the admitting chest radiograph. Two patients had undergone coronary artery bypass grafting before the present surgery (five and eight years, previously). Seven (25%) had undergone a previous cardiac catheterization; 6 within three months of the index surgery. Surgical procedures included carotid endarterectomy (5), abdominal aortic aneurysm repair (5) (emergent vascular surgery [2]), femoral embolectomy (1), other major abdominal surgery (7), orthopedic surgery (5), ophthalmologic surgery (2), craniotomy (1), mandibulectomy (1), and transurethral resection of the prostate (1). The duration of surgery ranged from one to 13 hours (average, four hours). Eighty-nine percent had been given general anesthesia. An intraoperative hypotensive episode (defined as a transient reduction of 50% or a 30% reduction for >10 minutes) was documented in 5.

The timing and presentation of myocardial infarction are summarized (*Tables 1 and 2*). Overall, 26 (93%) had myocardial infarction within the first two postoperative days. The presentation varied and included hypotension, chest pain, heart failure, arrhythmia, altered mental status, cardiopulmonary arrest, and nausea with hypertension.

Cardiac complications following myocardial in-

farction occurred in 17 (61%). These included cardiogenic shock in 7 (25%), arrhythmias (atrial fibrillation, premature ventricular beats, ventricular tachycardia, ventricular fibrillation, and complete heart block) in 6 (21%), heart failure in 3 (11%), and rupture of the myocardium in 1 (4%).

Forty-three percent of the patients died; cardiac causes were directly responsible in 10 (83%) (cardiogenic shock in 7, malignant ventricular arrhythmias in 2, and ventricular myocardial rupture in 1). Sixteen of 28 patients (57%) with an intraoperative or postoperative myocardial infarction survived and were eventually discharged from the hospital.

Discussion

There are numerous physiological and biochemical changes which occur during the operative and postoperative period. Many of these changes, including the induction of anesthesia, fluctuation of intravascular volume, anxiety, pain, and at times, fever with or without infection, increase the overall metabolic requirement and ultimately increase myocardial oxygen demand. Patients with underlying coronary artery disease may be unable to meet these demands, resulting in ischemia and myocardial infarction.⁹

Improved techniques have substantially reduced the general risk accompanying surgical procedures. As a result, perioperative complications now usually involve the cardiovascular system. The risk of myocardial infarction and/or cardiac death associated with surgery has been estimated to be approximately 0.2%.¹⁰ However, the risk of cardiac complications is increased in patients with coronary artery disease, particularly those that have had a myocardial infarction within six months of surgery.³⁻⁶ Identification of high-risk patients and careful perioperative hemodynamic monitoring may assist in reducing morbidity and mortality,^{11,12} and coronary artery bypass grafting has been shown to improve noncardiac surgical outcome in patients with severe coronary artery disease.¹³⁻¹⁶

The classic presentation of myocardial infarction with radiating substernal chest pain may be masked by incisional distress, sedation, analgesia, and noncardiac postoperative complications. Non-anginal modes of presentation included heart failure and various atrial and ventricular arrhythmias. Driscoll et al¹⁷ studied 500 patients in the postoperative period and were able to

Table 2. Clinical presentation of postoperative myocardial infarction

Clinical signs/symptoms	Number of patients (percent)
Hypotension	11 (39%)
Chest pain	11 (39%)
Congestive heart failure	7 (25%)
Cardiopulmonary arrest	1 (4%)
Altered mental status	2 (7%)
Arrhythmia (new onset)	5 (18%)
Nausea, hypertension	1 (4%)

document 12 myocardial infarctions—2 presenting with chest pain, 4 with intraoperative hypotension, 3 with postoperative hypotension, and 1 with acute pulmonary edema. More recent studies conducted by Goldman et al^{7,8} involving 1,001 patients undergoing a major noncardiac surgical procedure identified 18 patients with perioperative myocardial infarction. Nine patients (50%) experienced chest pain while the remaining patients experienced new or worsening heart failure, hypotension, and supraventricular arrhythmias. The 50% incidence of painless myocardial infarction contrasts with the 10%–20% rate observed in the general population.^{18,19} While myocardial infarction may occur at any time in the postoperative period, studies suggest that >90% occur within the first six days, with a peak incidence at day three.^{3,7,8} A 50% mortality rate has been observed.⁹

The electrocardiogram remains a sensitive indicator of myocardial ischemia and injury; however, nonspecific ST and T wave changes following major intrathoracic and intraabdominal procedures necessitate the use of more specific tests. Serum enzyme evaluations are too nonspecific to be useful. The MB fraction of creatine kinase (CK-MB) provides the most rapid, sensitive, specific, and cost-effective means of detecting myocardial injury.²⁰ Radionuclide scanning has been useful for identifying true transmural myocardial infarction, but its sensitivity in nontransmural infarction is less and therefore cannot be routinely used for diagnosis.²¹

This type of retrospective analysis is subject to the well-recognized errors of omission and inclusion which can affect coded medical records. At our institution, aggressive awareness of coronary disease may have altered the population exposed to surgical risk, but with this in mind, our analysis suggests that the incidence of myocardial infarc-

tion in the postoperative period is low (0.09%). As with other series, we noted myocardial infarction following a broad range of surgical procedures. Major abdominal, thoracic, and vascular surgical procedures predominated. Emergent vascular surgery, particularly symptomatic abdominal aortic aneurysm resection, was often complicated by myocardial infarction. The average age of our study population was 71 years, which is in itself a risk for cardiac complications.^{7,8,22} Furthermore, 64% of patients gave a history of angina pectoris and 50% of these had electrocardiographic evidence of previous myocardial infarction; these percentages were the result primarily of the tertiary nature of our institution. No patient was identified who was thought to have experienced a myocardial infarction within six months of the time of surgery, but one quarter of the patients experiencing a postoperative myocardial infarction had undergone coronary arteriography within three months of operation and were cleared for surgery "at increased risk."

Analysis of the timing of myocardial infarction yielded findings at variance with other studies. Thirty-nine percent had myocardial infarction identified either during surgery or within the first 12 postoperative hours. Ninety-three percent had myocardial infarction within two days of surgery.

The 43% mortality rate following myocardial infarction is consistent with other studies^{5,6-9} and emphasizes the serious nature of this entity.

Conclusion

Patients with coronary artery disease are at risk for perioperative myocardial infarction with significant morbidity and mortality. The clinical presentation is frequently atypical, with hypotension, altered mental status, heart failure, and various arrhythmias being the important signs which a clinician must recognize. The identification of a high-risk patient may warrant further preoperative evaluation with provocative coronary testing or formal coronary arteriography.

Donald A. Underwood, M.D.
Department of Cardiology
The Cleveland Clinic Foundation
9500 Euclid Ave.
Cleveland, OH 44106

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