Myocardial Infarction After General Anesthesia

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During 1967 and 1968, a total of 32,877 patients had general anesthesia at the Mayo Clinic; 422 had previous myocardial infarction. Of these 6.6% experienced another infarction during the first postoperative week. There was no relationship between incidence of postoperative reinfarction and type or duration of anesthesia. However, operations on the thorax and upper abdomen were followed by three times as many reinfarctions as operations at other sites. Patients who were operated on within three months of infarction had a 37% reinfarction rate. This rate decreased to 16% in patients at three to six months after infarction, and remained at 4% to 5% when infarction had occurred more than six months previously. A significantly higher number of myocardial infarctions occurred during the third postoperative day.

A survey by the National Center for Health Statistics estimated that there were 111.1 million adults in the United States between 18 and 79 years of age during the years 1960 to 1962. Of these, 3.1 million had definite coronary heart disease, and 2.4 million were suspected of having it. Definite myocardial infarction had occurred in an estimated 1.4 million adults.[1] The number of patients with coronary heart disease or myocardial infarction who require some form of surgical operation will increase steadily as the population increases. Considering the stress of anesthesia and surgery, these patients present problems related to their specific cardiac pathological findings.

In spite of these large numbers, few statistics are available regarding the incidence of primary or recurrent myocardial infarction after anesthesia. Death rates and their relation to age and sex, and to type and duration of anesthesia (in existing reports) are based on a relatively small number of cases. This review attempts to provide additional data on these questions by analyzing a two-year experience in a large anesthetic practice.

Patients Studied and Method

During the years 1967 and 1968, a total of 32,877 patients, 30 years of age and over, underwent some form of operation or diagnostic procedure under general anesthesia at our institution. (Cardiac operations were not included.) Among these, 422 patients had evidence of previous myocardial infarction indicated by medical history or by electrocardiography before operation. The yearly distribution is shown in Table 1. Twenty-eight of them (6.6%) experienced another infarction during the first week after the operation, indicated by clinical symptoms, electrocardiogram, enzyme studies, or postmortem examination. Forty-three other patients also had infarctions during this same postoperative period—0.13% of all patients without previous history of myocardial infarction, having anesthesia (Table 1).

The relationship of patients with previous myocardial infarction to sur-

Table 1.—Incidence of Myocardial Infarction Related to Previous Infarction

History	General Anesthesia (No.)	Myocardial Infarction One Week Postoperatively	
		No.	%
Previous myocardial infarction			
1967	218	13	6.0
1968	204	15	7.4
Total	**422**	**28**	**6.6**
No previous myocardial infarction			
1967	15,597	19	0.12
1968	16,858	24	0.14
Total	**32,455**	**43**	**0.13**

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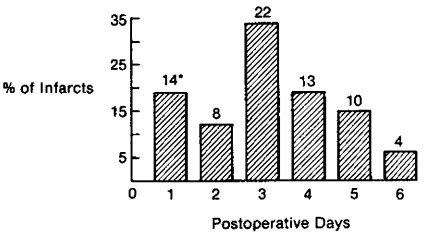
Table 2.—Relation of Myocardial Infarction to Previous Infarction and to Surgical Population

Age, yr	General Anesthesia (No.)	Total Previous Myocardial Infarction per 1,000 Anesthetized	Myocardial Infarction in Men		Myocardial Infarction in Women	
			Previously	Again, Post-operatively	Previously	Again, Post-operatively
30-39	4,081	0.7	3	...	...	...
40-49	6,906	3.6	24	2	1	...
50-59	8,825	10.5	75	5	18	...
60-69	8,375	20.9	147	13	28	...
70-79	4,051	27.9	90	6	23	1
80+	639	20.3	10	1	3	...
Total	**32,877**	12.8	**349**	**27**	**73**	**1**

Table 3.—Preoperative Heart Disease and Myocardial Infarction After General Anesthesia

Preoperative Status	No. of Cases	Myocardial Infarction, First Week Postoperatively			
		Deaths			
		Total		In 48-hr Postoperative Myocardial Infarction	
		No.	%	No.	%
Myocardial infarction	28	15	54	12	80
Coronary heart disease					
Known	16	14	87	9	64
Unknown	27	15	56	11	73
Total	**71**	**44**	**62**	**32**	**73**



*Distribution of myocardial infarctions by postoperative days. *Number of patients.*

Table 4.—Relation of Myocardial Infarction to Anesthetic Agents

Agents and Mixtures	Myocardial Infarction		
	Previously	Again, Post-operatively	Again, %
Thiopental, O_2, N_2O, tubocurarine			
With methoxyflurane	57	5	8.8
With halothane	268	18	6.7
With ether	66	4	6.1
With pentazocine	3	...	...
Thiopental, O_2, N_2O	21	...	...
With halothane, gallamine	1	1	...
With gallamine	1	...	...
With cyclopropane	1	...	...
Thiopental, diazepam	2	...	...
Thiopental, O_2, surgical infiltrate	1	...	...
Innovar, *O_2, N_2O, tubocurarine	1	...	...
Total	**422**	**28**	**6.6**

*Mixture containing droperidol and fentanyl citrate.

Table 5.—Duration of Anesthesia and Myocardial Infarction After General Anesthesia

Anesthesia (min)	Myocardial Infarction				
	In Men		In Women		
	Previously	Again, Post-operatively	Previously	Again, Post-operatively	Again (%) (Men & Women)
0-59	35	3	11	...	6.5
60-119	66	4	12	...	5.1
120-179	39	4	14	...	7.5
180-239	20	1	4	...	4.2
240-299	12	...	3	1	6.7
300-359	2	...	...	...	...
Total	**174**	**12**	**44**	**1**	**6.0**

gical population by age and sex, and their reinfarction ratio, is shown in Table 2. Myocardial infarction is primarily a disease of men. Of every 1,000 anesthetized patients, 12.8 had had a previous myocardial infarction. Fifteen of 28 patients (54%) died after reinfarction, with 12 of these deaths (80%) occurring during the first 48 hours after myocardial infarction (Table 3). Forty-three of the 71 patients who experienced an infarction had no previous evidence of myocardial infarction, but 16 had known coronary heart disease with angina. The other 27 had no history of coronary disease, but six of them were diabetics and ten had hypertension which required treatment. The mortality of these first infarctions is also high.

The patients received a variety of general anesthetic agents and muscle relaxants (Table 4) without influencing the incidence of reinfarction. Duration of anesthesia ranged from 20 minutes to six hours, yet the incidence of reinfarction did not change as time increased (Table 5).

The relationship of site and type of operation to recurrence of myocardial infarction is shown in Table 6. When analyzed by the chi-square test, the reinfarction ratio in operations of the thorax and upper abdomen was significantly higher ($P < .001$) than for

Table 6.—Relation of Myocardial Infarction to Site and Type of Operation

Site and Type of Operation	Myocardial Infarction: In Men: Previously	In Men: Again, Post-operatively	In Women: Previously	In Women: Again, Post-operatively	Again (%) (Men & Women)
Thorax and upper abdomen	(113)	(15)	(18)	(1)	(12.2)*
Great vessels	49	5	5	...	9.0
Lung	14	5	...	...	36.0
Other intrathoracic	4	3	...	...	75.0
Biliary, upper abdomen	46	2	13	1	5.0
Other	(236)	(12)	(55)	...	(4.1)*
Extraperitoneal abdominal	5	1	2	...	14.0
Endoscopic: oral	8	2	...	...	25.0
perineal	5	2	...	...	40.0
Perineal GU†	48	2	...	...	4.0
Anorectal	7	1	...	...	14.0
Vertebral column	14	1	2	...	6.0
Extremities, bone	18	2	5	...	9.0
Head and neck	13	1	5	...	6.0
Miscellaneous	118	...	41	...	...
Total	**349**	**27**	**73**	**1**	6.6

*Difference between groups is significant ($P < .001$).
†Genitourinary.

the other types of operations that were studied (Table 6).

The relationship of incidence of postoperative infarction to interval since previous myocardial infarction is shown in Table 7. Thirty-seven percent of patients operated on within three months of myocardial infarction had postoperative reinfarctions. This decreased to 16% in patients between three and six months after infarction, and remained 4% to 5% in patients more than six months after previous infarction.

The Figure depicts the distribution of myocardial infarction on various postoperative days. There were significant day-to-day differences in the frequency of myocardial infarction, with third-day incidence being highest ($P < .01$).

Six of the 28 patients did not have chest pain with reinfarction. Suspicion of an acute infarct came from the postoperative ECG, or from clinical findings, such as irregular pulse, which led attending physicians to a full investigation.

Table 7.—Relation of Myocardial Infarction to Interval From Previous Myocardial Infarction

Months	Myocardial Infarction: In Men: Previously	In Men: Again, Post-operatively	In Women: Previously	In Women: Again, Post-operatively	Again (%) (Men & Women)
0-3	8	3	...	...	37
4-6	15	3	4	...	16
7-12	31	2	11	...	5
13-18	26	1	1	...	4
19-24	19	1	2	...	5
25+	186	10	46	1	5
Old	64	7	9	...	10
Other*	...	...	...	...	...
Total	**349**	**27**	**73**	**1**	6.6

*Age not recorded for myocardial infarction.

Comment

Coronary heart disease may begin early in adult life, but rarely manifests itself before 45 years of age. Myocardial infarction is much more common in men than women and its prevalence rises with age, the 65- to 74-year-old age group having the greatest incidence. This was also true in the surgical population, yet the reinfarction ratio did not change significantly in our study for older age groups. Our present study also indicates that patients with previous myocardial infarction who undergo general anesthesia and surgery have a 50 times greater chance of reinfarction than those who do not have a history of myocardial infarction.

Reports on rates of postoperative myocardial infarction differ widely. Baer et al[2] report that 41 of 150 patients older than 30 years of age had myocardial infarction after operation. Walker and Macdessi[3] found evidence of myocardial infarction among 26 of 100 patients older than 65 years. Patients in both these studies were randomly selected, and some had previous myocardial infarction or evidence of coronary heart disease. Knapp et al[4] reported that among 427 patients with a previous history of coronary occlusion, 26 had reinfarctions. Arkins et al[5] collected a series of 240 patients with previous myocardial infarction, of whom 54 died during the first two months after operation. Mauney et al[6] relates a prospective study in which 30 of 365 patients, age 50 years or over, had myocardial infarction after operation, with 16 deaths.

Comparing these figures is difficult because of the wide variety of factors involved, such as age, type of hospital, methods of diagnosing myocardial infarction, other preexisting illnesses, type of operation, and postoperative care. However, one conclusion is common to all reports: There is a high incidence of postoperative myocardial

infarction in patients who have had previous infarction, even when it was long before the operation.

Fifty-four percent of our patients who had previous myocardial infarction died as a result of recurrent myocardial infarction (similar to the 53% mortality cited by Mauney et al.[6] By comparison, the mortality from myocardial infarction in a general hospital is approximately 30%, and in a coronary-care unit this may be reduced to 15% to 20%.[7] So myocardial infarction, or recurrent infarction, after anesthesia and a major operation, is more serious and lethal than myocardial infarction alone.

Others have reported that the shorter the interval between previous myocardial infarction and major operation, the greater the hazard of reinfarction.[4] In the series of Arkins et al,[5] 27 patients had infarction which was less than three months old; 11 of them (40%) died during or after operation. In ten of these patients the cause of death was directly related to myocardial infarction. In our series, the reinfarction rate was 37% among the patients with infarction less than three months previously; the incidence dropped to 16% when the myocardial infarction was three to six months old. Because the reinfarction rate stabilizes at 5% after six months, elective surgery should be postponed beyond this time. Only life-threatening emergencies should be considered for surgery less than six months after a patient has suffered a myocardial infarction.

About one third of patients having a myocardial infarction and reaching the hospital die in the first 48 hours.[8] However, 80% of our postoperative patients died within 48 hours after myocardial infarction, which suggests that arrhythmia, rather than a low cardiac output due to myocardial failure, may be the primary cause of death. Since these infarcts occurred in hospitals, one can reasonably assume that a lower mortality could be obtained if all patients with previous coronary heart disease and myocardial infarction were monitored carefully, and early measures were taken to treat previous serious rhythm disturbances. At present, the ideal environment for such a patient is an intensive coronary care unit (ICCU) or its equivalent.

Several factors may precipitate myocardial infarction during and after operation: tachycardia, hypoxemia, hypotension, hemorrhage, and lowered cardiac output.[9] These complications are more frequent after surgery of the great vessels, lung, and the upper abdomen. As a group, these more-major kinds of operations were followed by three times as many infarctions as any other type of operation. This fact indicates the need for close attention to maintaining optimal blood volume and pressure in the postoperative period.

Six of our 28 patients (21%) had silent, recurrent infarction, discovered electrocardiographically or clinically after operation. Chest pain at this time may be absent or obscured because of narcotics and sedatives. Serial electrocardiographic tracings performed daily for up to a week after operation, for comparison with a baseline ECG taken prior to operation, are indicated in patients who have hypertension, coronary disease, and previous infarction.

Hypoxemia (when breathing air) occurs to some degree after most general anesthetics and major operations. We have found in a different study that after abdominal surgery, arterial oxygen tension decreases for at least three postoperative days (2%, 11%, and 12% respectively), largely due to miliary atelectasis, pulmonary shunting, and possibly decreased cardiac output.[10] Another reason, then, for having patients who have had previous infarction, and those who have coronary disease, in intensive-care areas postoperatively is that oxygen can be administered more carefully. They need not only an increased inspired oxygen tension for several days but also special attention to chest physiotherapy—coughing, deep breathing, chest pounding, regular turning, and dangling of the legs. By these means, atelectasis may be minimized, myocardial oxygen supply kept adequate, and infarction avoided.

It has been suggested that there is a tendency for excessive thrombus formation in men who have had previous myocardial infarction.[11] The coagulability of blood is increased during the second to seventh postoperative days.[12] Results of prolonged anticoagulation to prevent recurrent myocardial infarction have been controversial in the past,[13] yet, to our knowledge, short-term (up to one week) prophylactic anticoagulation for postoperative, recurrent myocardial infarction has not been evaluated.

The significance of the combined effects of all these factors on the incidence of myocardial infarction after operation, especially during the third postoperative day (Figure), is not clearly documented. Certainly, these high-risk patients should be watched closely and treated aggressively, postoperatively, in an attempt to make anesthesia and surgery safer for them.

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