Myocardial Infarction After General Anesthesia*

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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, and 2.4 million had suspected, coronary heart disease. Definite myocardial infarction had occurred in an estimated 1.4 million adults (USNCHS, 1965). 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 pathology.

In spite of these large numbers, few statistics are available about the incidence of primary or recurrent myocardial infarction after anesthesia. Mortality 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 2-year experience in a large anesthetic practice.

Material and Method. During the years of 1967 and 1968, 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 by history or by electrocardiography before operation. Their distribution for these years is shown in Table 1. Twenty-eight of them (6.6%) reinfarcted after operation during the first week, as indicated by clinical symptoms, electrocardiogram (ECG), 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 surgical 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, 12.8 patients had had a previous myocardial infarction. Fifteen of 28 patients died after reinfarction (54%), with 12 of these deaths occurring during the first 48 hours after myocardial infarction (80%) (Table 3). Forty-three of the 71 patients who infarcted 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 6 of them were

TABLE 1. Incidence of myocardial infarction related to previous infarction.

History	General anesthesia (no.)	Myocardial infarction 1st wk postop	
		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	General anesthesia (no.)	Total previous myocardial infarction/1,000 anesthetics	Myocardial infarction in men		Myocardial infarction in women	
			Previously	Again postop	Previously	Again postop
30 to 39	4,081	0.7	3			
40 to 49	6,906	3.6	24	2	1	
50 to 59	8,825	10.5	75	5	18	
60 to 69	8,375	20.9	147	13	28	
70 to 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

diabetic and 10 had hypertension requiring treatment. The mortality rate 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 6 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 ($P < 0.001$) than for other types of operation (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 3 months of myocardial infarction had postoperative reinfarctions. This decreased to 16% in patients between 3 and 6 months after infarction, and remained 4 to 5% in patients more than 6 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, the third day being highest ($P < 0.01$).

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, leading to a full investigation.

Discussion. 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-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 have

TABLE 3. Preoperative heart disease and myocardial infarction after general anesthesia.

Preoperative status	Cases	Myocardial infarction in first wk postop			
		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

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* (Baer, *et al.*, 1965) report that 41 of 150 patients older than 30 years of age had myocardial infarction after operation. Walker and Macdessi (Walker and Macdessi, 1966) 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* (Knapp, *et al.*, 1962) reported that among 427 patients with a previous history of coronary occlusion, 26 had reinfarctions. Arkins, *et al* (Arkins, *et al.*, 1964) collected a series of 240 patients with previous myocardial infarction, of whom 54 died during the first 2 months postoperatively. Mauney *et al* (Mauney, *et al.*, 1970) 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, kind of operation, and postoperative care. However, one conclusion is common to all reports: the high incidence of postoperative myocardial infarction in patients who had had previous infarction, even when the infarction was long before 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* [Mauney, *et al.*, 1970]). By comparison the mortality rate from myocardial infarction in a general hospital is approximately 30% and in a coronary care unit this may be reduced to 15 to 20% (Logue and Hurst, 1970). So myocardial infarction, or recurrent infarction, after anesthesia and a major operation, is more serious and lethal than myocardial infarction alone.

TABLE 4. Relation of myocardial infarction to anesthetic agents.

Agents and mixtures	Myocardial infarction		
	Previously	Again postop	% 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

Others have reported that the shorter the interval from previous myocardial infarction to major operation, the greater the hazard of reinfarction (Knapp, *et al.*, 1962). In the series of Arkins *et al* (Arkins, *et al.*, 1964), 27 patients had infarction under 3 months old; 11 of them (40%) died during or after operation. In 10 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 3 months previously; the incidence dropped to 16% when the myocardial infarction was 3 to 6 months old. Because the reinfarction rate was stable at 5% after 6

TABLE 5. Duration of anesthesia and myocardial infarction after general anesthesia.

Anesthesia, min	Myocardial infarction in men		Myocardial infarction in women		Myocardial infarction again (%) (M + W)
	Previously	Again postop	Previously	Again postop	
0 to 59	35	3	11		6.5
60 to 119	66	4	12		5.1
120 to 179	39	4	14		7.5
180 to 239	20	1	4		4.2
240 to 299	12		3	1	6.7
300 to 359	2				
Total	174	12	44	1	6.0

TABLE 6. Relation of myocardial infarction to site and type of operation.

Site and type of operation	Myocardial infarction in men		Myocardial infarction in women		Myocardial infarction again (%) (M + W)
	Previously	Again postop	Previously	Again postop	
Thorax & upper abdomen	(113)	(15)	(18)	(1)	(12.2)*
Great vessels	49	5	5		9
Lung	14	5			36
Other intrathoracic	4	3			75
Biliary, upper abdomen	46	2	13	1	5
Other	(236)	(12)	(55)		(4.1)*
Extraperitoneal abdominal	5	1	2		14
Endoscopic: oral	8	2			25
perineal	5	2			40
Perineal GU	48	2			4
Anorectal	7	1			14
Vertebral column	14	1	2		6
Extremities, bone	18	2	5		9
Head and neck	13	1	5		6
Miscellaneous	118		41		
Total	349	27	73	1	6.6

* Difference between groups is significant ($P < 0.001$).

months, elective surgery should be postponed beyond this time. Only life-threatening emergencies should be considered for surgery less than 6 months after a myocardial infarction.

About one third of patients having myocardial infarction alone die in the first 48 hours (Shapiro, *et al.*, 1969). 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 rate could be obtained if all those patients with previous coronary heart disease and myocardial infarction were monitored carefully and early measures taken to treat rate and rhythm disturbances. Intensive monitoring and care are needed.

Several factors may precipitate myocardial infarction during and after operation, such as tachycardia, hypoxemia, hypotension, hemorrhage, and lowered cardiac output (Dack, 1963). These complications are more frequent after surgery of the great vessels, lung, and the upper abdomen. As a group, these more major kinds of operation were followed by three times more infarctions than any other type of operation. This fact indicates the need

TABLE 7. Relation of myocardial infarction to interval from previous myocardial infarction.

Months	Myocardial infarction in men		Myocardial infarction in women		Myocardial infarction again (%) (M + W)
	Previously	Again postop	Previously	Again postop	
0 to 3	8	3			37
4 to 6	15	3	4		16
7 to 12	31	2	11		5
13 to 18	26	1	1		4
19 to 24	19	1	2		5
25+	186	10	46	1	5
Old myocardial infarction, age not recorded	64	7	9		10
Total	349	27	73	1	6.6

for close attention to maintaining optimal blood volume and pressure in the postoperative period.

Six of 28 of our patients 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 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 3 postoperative days (2%, 11% and 12% respectively), largely due to miliary atelectasis, pulmonary shunting, and possibly decreased cardiac output (Tarhan, *et al.*, 1969). Another reason, then, for having patients who have had previous infarction, and those who have coronary disease, in intensive care areas postoperatively is that they can be oxygenated better. 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.

That there is a tendency for excessive thrombus formation in men who have had previous myocardial infarction has been suggested (Goldenfarb, *et al.*, 1971). The coagulability of blood is increased during the second to seventh postoperative days (Grigoryan and Alimov, 1969). Results of prolonged anticoagulation to prevent recurrent myocardial infarction have been controversial in the past (Seaman, *et al.*, 1964), yet short-term (up to 1 week) prophylactic anticoagulation for postoperative recurrent myocardial infarction has not been tried to our knowledge.

The significance of the combined effects of all these factors on the incidence of myocardial infarction after operation, especially during the third postoperative day (fig. 1), is not clearly documented. Certainly these high-risk patients should be watched closely and treated agressively, postoperatively, in an attempt to make anesthesia and surgery safer for them.

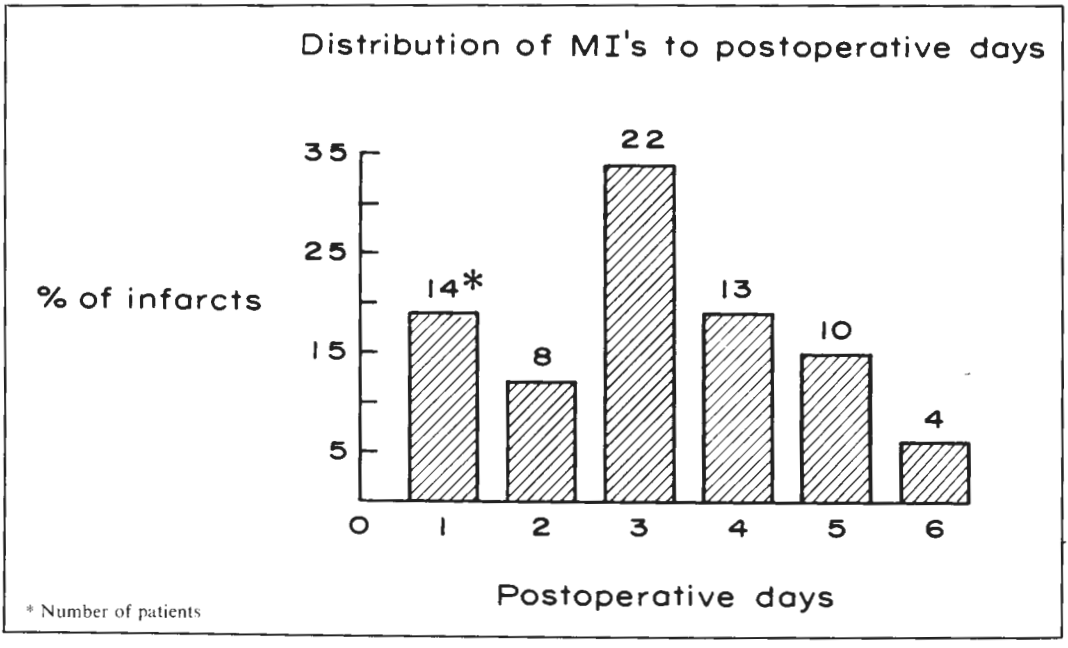

Fig. 1—Distribution of myocardial infarctions to postoperative days.

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