Clinical Reports

Non-cardiac surgery in patients with prior myocardial revascularization

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Patients who had undergone aorto-coronary bypass grafts (ACBG) were assessed for the incidence of cardiac complications in the postoperative period following subsequent non-cardiac surgery. One hundred and twenty-one patients had 13 complications (11 per cent). A significantly higher risk of cardiac complications (27 per cent) was found in patients undergoing non-cardiac procedures in the first month after ACBG. This remained higher (17 per cent) until the sixth month following ACBG. Significant factors which increased the risk of cardiac complications in the postoperative period included preoperative congestive heart failure (33 per cent), cardiac risk index score classification of III or IV (37 per cent), surgery on major vessels, and surgery necessitated because of a complication of the ACBG itself (17 per cent). No correlation was found between cardiac complication rates and recurrent angina, hypertension, the use of beta-blockers or digoxin, or anaesthetic technique. It is suggested that all but emergency surgery should be postponed in the first month following ACBG, and elective surgery be delayed for up to six months.

Key words

ANAESTHESIA: cardiovascular; SURGERY: prior cardiac; COMPLICATIONS, POSTOPERATIVE: myocardial infarction, cardiac.

Myocardial infarction (MI) occurs perioperatively in 0.15 to 2 per cent of all adult patients undergoing routine elective surgery.^{1,2} The incidence of reinfarction is much higher in patients with a recent (less than six months) MI.^{3,4} In addition, patients with documented coronary artery disease (CAD) have more intraoperative episodes of ST-segment and T wave changes on the electrocardiogram (ECG) suggestive of ischaemia and are at increased risk of cardiac complications during anaesthesia and non-cardiac surgery.^{5,6}

It is not clear whether or not myocardial revascularization by saphenous vein aorto-coronary bypass grafting (ACBG) has a protective effect in reducing the incidence of perioperative cardiac complications during subsequent non-cardiac surgery. Studies of small groups of patients have found decreased complications after ACBG. Mahar documented a lower risk of postoperative MI in patients who underwent ACBG prior to their non-cardiac surgery than in those who did not.⁷ McCollum and colleagues, studying post-ACBG patients undergoing major surgery, found only eight cardiac complications in 60 operations with no MIs and no deaths.⁸

Therefore, a study was designed to assess in detail the cardiac complication rate at our institution in patients with previous ACBG and to determine if there were any predictive risk factors. We reviewed the records for a 24-month period from 1979 to 1981 of all patients who had previously undergone ACBG and who then presented for non-cardiac surgery.

Methods

A total of 18,762 non-cardiac operations were performed at Emory University Hospital during the

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TABLE I Cardiac complications

Complication	Number	Number of deaths
MI	2	0
Ischaemia	2	0
Pulmonary oedema	3	2
Dysrhythmias	5	0
Multiple (Ischaemia, pulmonary oedema, dysrhythmias)	1	0

two-year period. Of this number, 121 patients had previously undergone ACBG. Only their first non-cardiac surgery after ACBG has been included in this study to eliminate the problem of multiple operations for the same disease. Medical, surgical, and anaesthetic histories were reviewed for pertinent data including the dates of previous MIs, if any; time since ACBG; and the presence of perioperative dysrhythmias, congestive heart failure, diabetes mellitus, chronic respiratory disease, hypertension or peripheral vascular disease. Medications including digoxin, propranolol, antiarrhythmics, and nitrates were noted. The American Society of Anesthesiologists (ASA) physical status was recorded and the patients were retrospectively assigned a Cardiac Risk Index Score (CRIS) as described by Goldman but modified to exclude aortic stenosis.^{9,10}

Perioperative events were obtained from the anaesthetic and recovery room records, intensive care unit and postoperative notes, and laboratory results. Intraoperatively, hypertension was defined as systolic blood pressure (SBP) over 22 kPa (160 torr); hypotension as SBP under 12 kPa (90 torr); tachycardia as heart rate (HR) above 100 beats/minute (bpm); and heart failure as pulmonary capillary wedge pressure (PCWP) above 2.4 kPa (18 torr), central venous pressure (CVP) above 2 kPa (15 torr), or the presence of pulmonary oedema. New ST-segment or T wave changes on the ECG, dysrhythmias, oliguria (urine output < 40 mL/hr), and metabolic acidosis (pH < 7.2) were also noted. The surgical site, duration of surgery, anaesthetic technique, and the extent of monitoring were recorded. Postoperative complications included MIs defined by the presence of new Q waves on the ECG and elevated creatine phosphokinase-myocardial band (CPK-MB) over ten per cent of the total CPK; congestive heart failure determined clinically or

radiologically; new dysrhythmias, either supraventricular or ventricular which required therapy; and death.

Results were compared between different groups using the Fischer exact probability test.

Results

A Complications

Thirteen of the 121 patients (11 per cent) in this series had cardiac complications (Table I). One patient had multiple complications including pulmonary oedema, dysrhythmias, and ST-segment changes. Two deaths occurred postoperatively (1.7 per cent) due to multi-system failure following prolonged low cardiac output states with pulmonary oedema. Two patients developed new myocardial infarctions, one transmural and the other subendocardial, while three other patients had ischaemia evidenced by ST-segment and T wave changes. Six patients developed dysrhythmias requiring treatment. None of these cardiac complications led to mortality. In addition, four patients had pulmonary oedema, with two deaths (see above). There were no episodes of documented heart block.

B "Risk" factors (Tables II and III)

The 121 patients in this study had a mean age of 57 years (range 35–77), and 85 per cent were male. There was no statistical difference in the rate of cardiac complications in this series on the basis of age or sex.

Fifty-two operations (43 per cent) were undertaken less than six months after cardiac revascularization surgery, either as the result of the ACBG (sternal debridement necessitated by mediastinitis, plastic reconstruction required secondary to wide debridement, or embolectomy of peripheral arteries), or for an unrelated surgical problem. Seventeen per cent were followed by complications, including both of the new MIs and one of the two deaths. The complication rate for this group was significantly greater than that associated with the 69 procedures done more than six months after revascularization. Of the 22 procedures done less than one month following ACBG, 27 per cent developed cardiac complications postoperatively.

Operations performed for reasons related to the previous ACBG, on patients in congestive heart failure, on patients with CRIS Class III or IV, or on

TABLE II Pre-operative risk factors and cardiac complication rate

<i>Risk factor</i>	<i>Number of patients with risk factor (N = 121)</i>	<i>Number (%) complicated (N = 13)</i>
Male	103	11 (11)
ACBG < 6 mos prior to surgery	52	9 (17)*
ACBG < 1 mo prior to surgery	22	6 (27)*
Operation related to prior ACBG	35	6 (17)*
Any prior MI	88	10 (11)
MI < 6 mos prior to surgery	14	1 (7)
MI after ACBG	10	1 (10)
Recurrent angina	23	5 (22)
Preoperative CHF	12	4 (33)*
Digoxin	71	6 (8)
β -Blockers	51	4 (8)
Antiarrhythmics	14	2 (14)
Hypertension	41	4 (10)
ASA $\geq$ 3	117	13 (11)
CRIS $\geq$ III	19	7 (37)*

*P < 0.01 by Fischer exact probability test compared to patients without the risk factor.

TABLE III Intraoperative risk factors and cardiac complication rate

<i>Risk factor</i>	<i>No. patients with risk factor (N = 121)</i>	<i>No. (%) complications (N = 13)</i>
Surgical site:		
Sternum	25	6 (24)*
Thorax and abdomen (excluding major vascular)	32	2 (6)
Major vascular	10	4 (40)*
Other	54	1 (2)
Surgical duration:		
Surgery > 5 hours	9	2 (22)
Surgery > 3 hours	46	5 (11)
Intraoperative events:		
HR > 100	12	2 (17)
SBP > 160	32	2 (6)
SBP < 90	8	0 (0)

*P < 0.01 by Fischer exact-probability test compared to patients without the risk factor.

the sternum or major vessels had statistically significant complication rates.

Many of the risks suggested by other studies and clinical experience did not show statistical significance. In particular, the length of the procedure, the ASA physical status, intraoperative events, pre-existing non-cardiac disease and the preoperative medications did not influence postoperative morbidity.

Discussion

Coronary artery disease is widespread in our society with more than one per cent of white males newly diagnosed each year.¹¹ Postoperative MI rates after non-cardiac surgery in the general population are low.^{1,2} In contrast, patients with recent preoperative MIs who require non-cardiac surgery have a high reinfarction rate and a dismal outcome. Steen *et al.*, as recently as 1978, demonstrated a 27 per cent incidence of reinfarction in patients undergoing surgery less than three months following an MI, with a mortality rate approaching 50 per cent.⁴ By six months after an MI, the reinfarction rate had diminished to less than five per cent. Rao and El-Etr in 1980, however, suggested a reduction in operative post-MI using more invasive intra- and post-operative monitoring.¹²

Over 100,000 ACBG procedures are being performed annually in the United States with a five-year survival exceeding 90 per cent.¹³⁻¹⁵ Many of these patients will undergo subsequent non-cardiac surgery. It has been thought that even after ACBG, patients with CAD would be at increased risk of cardiac complications during anaesthesia and surgery. The reinfarction rate (1.1 per cent), total new infarction rate (1.6 per cent), mortality rate (1.7 per cent), and overall complication rate (11 per cent) in our series of patients after ACBG was low in comparison with patients after prior MIs.^{3-5,12}

However, the complication rate is still higher than that for the general population.

It may be argued that only the healthier patients with CAD undergo and survive ACBG. However, mortality figures for all patients presenting for ACBG are low, ranging from 0.3 to 5 per cent.¹³⁻¹⁵ Even for the poorest candidate (multiple vessel disease with severe left ventricular failure) mortality is only 3.4 to 6 per cent.^{16,17} It was difficult in our patients to assess their preoperative left ventricular function prior to non-cardiac surgery, but the presence of nocturnal angina or congestive heart failure seemed to be the best available indicators. Nine per cent of our patients had preoperative congestive heart failure and 27 per cent had recurrent angina, suggesting that we were not biasing our population with patients who had good ventricular function.

Our results agree with and extend previous studies of patients after ACBG. Mahar *et al.* compared cardiac morbidity in two groups of patients with coronary artery disease – one group without prior ACBG.⁷ They showed a reduced incidence of perioperative MI with prior ACBG. All three of the patients in their non-ACBG group who developed postoperative MIs were clearly candidates for ACBG; however, it was elected to do their non-cardiac operations first. McCollum *et al.* found no postoperative reinfarctions in patients with prior ACBG, and their cardiac complication rate (13 per cent) was approximately the same as ours.⁸ However, they did not include, as we did, people undergoing non-cardiac surgery during the same hospitalization as the one for their original ACBG. Schur and Tice, studying a series of 20 patients who had ACBG prior to their non-cardiac surgery, reported a four per cent mortality and a 21 per cent cardiac complication rate although none of their patients demonstrated significant recurrent symptoms of coronary insufficiency.¹⁸ These studies, plus our data, support the concept that prior myocardial revascularization is not a major risk but may indeed be beneficial in patients with coronary artery disease undergoing non-cardiac surgery. Crawford *et al.* reported the outcome for 358 patients who underwent non-cardiac surgery from one month to many years post-ACBG.¹⁹ The complication rates were very similar to ours: a mortality rate of one per cent and perioperative MI rate of 1.1 per cent. Seventy-five per cent of the

mortality and most of the complications occurred in patients undergoing non-cardiac surgery within 30 days of ACBG. This agrees with our findings of the significantly increased risk of complications in patients requiring operations for reasons related to their coronary artery surgery and in the entire subgroup operated upon less than one month after ACBG. This interval (one month) may be an important period for stabilization and recovery following ACBG, during which elective surgery should not be performed because of the high risk of cardiac complications.

In our study, three other preoperative factors were clearly associated with increased morbidity – preoperative congestive heart failure, CRIS classification III or IV, and major vascular surgery. This supports the recent findings of Jeffery *et al.* that postoperative cardiac complications following vascular surgery are not assessed with the CRIS score.²⁰ The absolute numbers of reinfarctions and deaths were too low to correlate with specific risk factors, but there was a trend for these two complications to be associated with preoperative congestive heart failure, vascular surgery, and surgery of long duration.

The ASA physical status was too encompassing to have a predictive value. Preoperative medication, untoward intraoperative events, and many preoperative non-cardiac diseases appeared to have little effect on the rate of postoperative cardiac complications in our patient population. The CRIS index did predict the occurrence of cardiac complications. However, it should be noted that the presence of congestive heart failure was the main contributor to the high CRIS value in our patients (Figure).

In summary, the risk of postoperative cardiac complications in a patient who has previously undergone ACBG is about 11 per cent, with an increased risk (17 per cent) in the six months following the ACBG, and a 27 per cent chance of complications in the first month after cardiac surgery, when most of the morbidity is related to complications of the earlier ACBG. The reinfarction rate (11 per cent) was much less than that of patients from other studies with a prior MI, who had not undergone ACBG; and approached that of the general population. Indeed, in those who underwent ACBG more than six months prior to a subsequent non-vascular operation, the cardiac

FIGURE Incidence of complicated procedures, according to presence of risk factors.

complication rate was less than two per cent. Perioperative congestive heart failure, CRIS classification of III or IV, and major vascular surgery all significantly increased the risk of a postoperative cardiac complication in previously-bypassed patients undergoing non-cardiac surgery.

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Résumé

Des patients ayant déjà subi un pontage aorto-coronarien (P.A.C.) ont été suivis pour évaluer l'incidence des complications cardiaques post-opératoires après une chirurgie non cardiaque. 121 patients ont eu 13 complications (11 pour cent).

On a retrouvé un risque significativement plus élevé au cours du premier mois suivant leur P.A.C. Le risque est demeuré plus élevé (17 pour cent) jusqu'à six mois suivant leur P.A.C. Les facteurs qui semblent augmenter le risque de complications cardiaques dans la période post-opératoire incluent: l'insuffisance cardiaque congestive pré-opératoire (33 pour cent), une chirurgie de gros vaisseaux et une chirurgie justifiée par une complication du P.A.C.

On n'a retrouvé aucune corrélation entre le taux de complication cardiaque et la récurrence de l'angine, l'hypertension, l'usage de Béta-bloqueurs ou de digitales, ou la technique anesthésique. Il est donc suggéré qu'aucune chirurgie sauf la chirurgie d'urgence ne soit faite pendant le premier mois après le P.A.C. et que toute chirurgie élective soit retardée jusqu'à six mois.