Emergency myocardial revascularization

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Summary

From 1969 to 1975, 175 patients with acute coronary insufficiency underwent emergency saphenous vein aorto-coronary bypass grafting (SVBG). The patients were divided into two groups: group I, unstable angina (165 patients) and group II, acute evolving myocardial infarction (ten patients).

In group I, the hospital mortality was 8.4%, the incidence of post-operative myocardial infarction was 10.3%. Long-term follow-up was obtained for an average of 25 months, functional improvement was definite in the majority of the patients and actuarial survival curves show 87% patients alive at the end of 48 months.

In group II, the hospital mortality was 30%; seven of ten patients had good results.

Introduction

The present study deals with emergency coronary bypass surgery in 175 patients suffering from acute coronary insufficiency. These patients were operated on in the Cardiovascular Surgery Service of the Hôpital Broussais, Paris, from 1969 to 1975 and all underwent saphenous vein aorto-coronary artery bypass grafting (SVBG). They were all in a high risk category and were divided into two groups: group I, unstable angina, and group II, acute evolving myocardial infarction.

Definitions

(1) Group I—unstable angina

This is a high risk syndrome which denotes the recent onset (less than 3 months) of chest pain or the changes in pre-existing angina characterized by increasing severity and/or frequency of episodes of angina at rest which do not respond to medical treatment consisting of 24 hr in hospital with supportive measures and heparinization. Electrocardio-

grams taken during one or more episodes of chest pain show evidence of myocardial ischaemia such as T wave inversion or ST depression or elevation. Serum enzyme levels (LDH, SGPT, CPK) remain within the normal range. Also included in this group, are cases of angina with transient arrhythmias and the Prinzmetal variant of angina (Prinzmetal *et al.*, 1959).

(2) Group II—acute evolving myocardial infarction

This group comprises patients who underwent saphenous vein aorto-coronary by-pass procedures within the first 10 hr of a myocardial infarction as documented by electrocardiography (ST segment elevation, Q waves) and elevated serum enzyme levels.

Results were compiled in both groups by clinical examination, electrocardiography and repeat coronary arteriography in sixty-six patients.

Clinical material

A group of 175 consecutive patients with acute coronary insufficiency as defined above underwent SVBG on an emergency or semi-emergency basis in the cardiovascular surgical service of the Broussais Hospital in Paris between 1969 and 1975. There were 165 patients in group I, unstable angina, and ten patients in group II, acute evolving myocardial infarction.

Group I—unstable angina

This group consisted of 165 patients, 159 men and six women, of 39-69 years of age (mean, 54 years). One or more predisposing risk factors were present in 158 cases. In sixty-seven cases angina had been present for 5 years or more. There was a pre-existing myocardial infarction in eighty-four cases.

Of the patients, 122 presented with typical pre-infarction angina and forty-three had a Prinzmetal syndrome. Twenty-four had arrhythmias, particularly frequent in the Prinzmetal group, consisting of numerous premature ventricular contractions (ten), atrio-ventricular block (three), ventricular tachycardia (four) and ventricular fibrillation (seven).

Left heart failure was observed in two patients requiring the insertion of an intra-aortic balloon pump before operation. Coronary arteriography was followed immediately by operation in eighty-four cases which otherwise was performed between 1 and 7 days after arteriography. The lesions documented by coronary arteriography are summarized in Table 1. It is noteworthy that there were diffuse lesions involving the three main trunks in ninety cases. The most frequent contractile disorder was hypokinesia which varied in intensity and most often was limited to the ischaemic area; there was also akinesia or dyskinesia which, in certain patients, seemed to be related to the acute ischaemic episode.

TABLE 1. (Group I.) Distribution of coronary artery lesions seen on coronary arteriography and various ventricular configurations noted by ventriculography in unstable angina (165 patients)

Radiographic findings	
Coronary artery lesions	
(1) Artery	34
(2) Arteries	41
(3) Arteries or more	90
Ventriculogram	
Normal	30
Hypokinetic	
Moderate	50
Marked	27
Akinetic	8
Dyskinetic	2

Although the above was generally true for the forty-three patients with Prinzmetal angina, the coronary artery lesions in this group tended to be less extensive. Single artery disease was present in eighteen, and ventriculograms were normal in seventeen patients.

Operative technique

SVBGs were used in all cases with the aortic suture performed first. Extra-corporeal circulation was carried out using partial haemodilution and moderate hypothermia (31°C). Aortic cross-clamp time was limited to periods of 15 min and local hypothermia was used in five cases considered to be particularly risky. Left ventricular decompression was not used. Figure 1 shows the number of grafts and their distribution.

FIG. 1. Schematic representation of the various saphenous vein bypass grafts (SVBG) performed in group I at particular anatomical sites.

Two patients required post-operative circulatory assistance with the intra-aortic balloon pump. Anticoagulants were begun in the immediate post-operative period using heparin intravenously for the first 48 hr, then subcutaneously for 3 weeks before switching to antivitamin K preparations for long term anticoagulation.

Group II—acute evolving myocardial infarction

This group consisted of ten patients aged 36–62 years (mean 52 years). There were risk factors in all patients. Previous myocardial infarction was present in six cases. These patients were all operated upon during the acute early phase of myocardial infarction (within the first 10 hr). Five patients sustained myocardial infarction during and five immediately following coronary arteriography. Six of these patients were being studied for unstable angina. Five patients were in cardiogenic shock and one was brought to the operating theatre while undergoing external cardiac massage.

Coronary arteriography showed diffuse triple vessel disease in all cases. Ventriculography was performed in seven cases which revealed four areas of anterior hypokinesia and two areas of anterior akinesia. The operative protocol differed in two cases in which pre-operative femoro-femoral bypass was

necessary. Two cases required post-operative femoro-femoral cardiac assistance during more than 6 hr.

Results

Group I—unstable angina

The early post-operative mortality during the first month following operation was 8.4%. The causes of death are listed in Table 2. Myocardial infarction and left ventricular failure were the two most frequent causes of death. All but two of the patients who died had diffuse coronary arteriosclerosis as well as akinetic or hypokinetic left ventricles.

TABLE 2. (Group I.) Operative mortality and incidence of post-operative myocardial infarction in unstable angina (165 patients)

Operative mortality	14 (8.4%)
Intra-operative mortality	3
Cardiac failure	7
Infarctions	2
Miscellaneous	2
Post-operative necrosis	17 (10.3%)

Post-operative complications included: two cases of moderate heart failure which responded to vasopressors and isoproterenol, six cases of infarction (two of septicaemia and three of mediastinitis), and one gastro-intestinal haemorrhage which was treated medically. Arrhythmias inevitably responded to surgery and this was particularly true of the seven cases of recurrent ventricular fibrillation.

Post-operative myocardial infarction occurred in 10.3% of cases but almost one-third of them (five of seventeen) were in the non-grafted territory and two occurred at the end of the first month.

Repeat coronary arteriography was not performed in all patients. Sixty control studies were performed during the first 2 years. Of the total of seventy-two arteriograms performed, sixty-seven showed the grafts to be patent and five were thrombosed (6.9%). Ventriculograms were done in thirty patients and showed a definite improvement in ventricular contraction when the hypokinesia was slight but improvement was less marked when hypokinesia was severe (Fig. 2).

Long term follow-up was possible in eighty patients with a mean of 25 months following operation. Two patients died suddenly, 14 months and 17 months after operation. One late myocardial infarction occurred in the fifth month.

Functional improvement was present in seventy-five patients (Fig. 3). Of these, sixty-seven no longer had angina, eight continued to have some angina but to a lesser degree, three had no change. Fifty-eight patients resumed their professional activities.

Group II—early evolving myocardial infarction

Operative mortality in this group was 30%: two of ten patients died in cardiogenic shock within 36 hr and one died of a second infarction in the non-grafted territory on the eighteenth post-operative day.

The ECG shows that although the evidence of necrosis persisted the ST segment changes denoting ischaemia regressed rapidly following surgery.

Repeat coronary arteriography was performed in six patients and the grafts were patent. Two patients had arteriograms performed twice at yearly intervals

FIG. 2. (Group I.) Schematic representation of the evolution in ventricular function as documented by pre- and post-operative ventriculography (thirty patients). When contractility is slightly diminished, improvement is seen in the majority of cases; when hypokinesia is marked, improvement is partial.

FIG. 3. (Group I, unstable angina.) Functional results in seventy-eight patients with more than 6 months' follow-up. The majority of patients are asymptomatic or improved. Angina: □, absence; ▨, improved, ■, unchanged.

and they both showed marked improvement in left ventricular contraction.

From a functional point of view, seven patients state that they are asymptomatic and one is now 3 years following operation.

Discussion

The problem in defining unstable angina is a difficult one. The criteria gleaned from the literature vary according to the different authors. The present authors classify in their group I those patients who match the criteria for high risk as established by Fowler (1971), Goodin *et al.* (1973), Bronchek *et al.* (1974) and Matloff *et al.* (1975). Severe arrhythmia and the Prinzmetal variant of angina have been included in group I because of the increased risk from these conditions and worse prognosis (Silver-

man and Flamm, 1971; Ecker *et al.*, 1971; Levi and Proto, 1971; Graham *et al.*, 1973; Mundth *et al.*, 1973). The results show a significant hospital mortality as well as a high incidence of post-operative infarction. However, surgical indications have become more selective as experience has increased and the operative mortality in the last fifty consecutive cases is less than 5% and the incidence of post-operative infarction is 6%.

Results in emergency coronary surgery vary according to the different authors. Table 3b summarizes the experience of several groups. With a total of approximately 500 patients, the average hospital mortality is 10.2% and the incidence of post-operative infarctions is 8.6%.

Improvement in left ventricular contractility in cases of mild hypokinesia has been documented in the present study by comparing pre- and post-operative ventriculograms. These results have been confirmed by Chatterjee *et al.* (1972) using more precise criteria of contractility. Acute ischaemia may play an important role in ventricular dysfunction as shown in post-operative improvement by ventriculography. Relief of angina was quite striking in the present series, confirming the impressions of all other authors.

It remains to be determined whether or not emergency revascularization is indicated in unstable angina. On the one hand, 40–50% of patients with myocardial infarction have pre-infarction angina (Salomon, Edwards and Killip, 1969). On the other hand, the medical treatment of unstable angina is followed by an incidence of myocardial infarction ranging from 10 to 87% of cases according to the different series with a mean of 40%. The mortality rate following medical treatment also varies from 0 to 46% with a mean of 25%. From a functional point of

TABLE 3. The results of various published studies showing the mortality and incidence of infarctions on unstable angina treated medically (670 patients) in Table 3a or surgically (658 patients) in Table 3b

(a)	Infarction (%)	Mortality (%)	(b)	Operative necrosis (%)	Operative mortality (%)
Matloff <i>et al.</i> (1975)		40	Matloff <i>et al.</i> (1975)	7.7	3.4
Vakil (1964)	41	49.4	Favaloro <i>et al.</i> (1971)	6.2	11
Wood (1961)	43	30	Pifarre <i>et al.</i> (1971)	0	8
Beamish & Storrie (1960)	30	20	Lambert <i>et al.</i> (1971)	4	7
Krauss, Hutter & De Sanctis (1972)	35	15	Conti <i>et al.</i> (1973)		22.5
Resnik (1962)	3	0	Sustaita <i>et al.</i> (1973)	9.1	8.3
Sustaita <i>et al.</i> (1973)	87	46	Goodin <i>et al.</i> (1973)	8.3	13.3
Goodin <i>et al.</i> (1973)	71	43	Robinson <i>et al.</i> (1972)		14
Robinson <i>et al.</i> (1972)		20	Scanlon <i>et al.</i> (1971)	25	10
Conti <i>et al.</i> (1973)	10	10	Traad <i>et al.</i> (1973)	13.3	6.6
Fulton <i>et al.</i> (1972)	15	4	Wisoff <i>et al.</i> (1973)	12.5	6.6
Scanlon <i>et al.</i> (1971)	59	27	Cheanvechai <i>et al.</i> (1973)	9.8	6.6
Gazes <i>et al.</i> (1973)		18			
Corday (1971)		50			
Mean ± s.e. mean	40.2 ± 16.8	25.56 ± 9.2		8.6 ± 3.2	10.23 ± 6.6

view, more than 50% of the patients have severe residual angina. The mortality rate as shown by the retrospective study of Gazes *et al.* (1973) is 8% annually. The actuarial survival curves between the patients in this study and those of Gazes *et al.* (1973) have been compared and there appears to be an improved prognosis following surgical treatment (Fig. 4). This has been confirmed by the studies of Bronchek *et al.* (1974) and Matloff *et al.* (1975). A major objection, however, is that most of these studies deal with groups of non-homogeneous patients. Only prospective randomized studies based on rigorous criteria for patient selection will allow for the more precise determination of the comparative results of surgical versus medical treatment in unstable angina. Bertolasi *et al.* (1974), in spite of a short follow-up period of 8 months, in their randomized prospective study, showed an improved prognosis for the high risk patient undergoing surgery.

FIG. 4. Comparison of actuarial curves of patients with unstable angina: group I patients treated by SVBG at the Broussais Hospital, Paris, group II low risk patients treated medically (Gazes *et al.*, 1973), group III high risk patients treated medically (Gazes *et al.*, 1973). At the end of 48 months, the probability of survival is 87% for group I, 65% for group II and 37% for group III.

Group II (patients in the acute phase of myocardial infarction) represents a substantially different aspect of the authors' experience with emergency myocardial revascularization. Several experimental studies (Deloche *et al.*, 1972; Maroko *et al.*, 1972) have shown that early reperfusion may limit the extent of infarction. These studies show that in the early phase of infarction, a marginal zone exists in which the myocardial cells are not irreversibly damaged and may be salvaged by early reperfusion (Cox *et al.*, 1968; Camilleri *et al.*, 1975). Several authors have published data concerning either massive infarction in cardiogenic shock operated on with intra-aortic balloon pump support (Mundth *et al.*, 1973) or infarctions occurring during coronary angiography (Cheanvechai *et al.*, 1973; Scanlon *et al.*, 1973). The operative mortality in the latter group is between 5 and 10%. Scanlon *et al.* (1973) confirmed the findings, where were noted in certain of the patients in

group II, of early regression ST segment elevation. Cheanvechai *et al.* (1973) demonstrated that in the majority of operated cases, ventricular function is improved.

These clinical and experimental studies stress the need to be aggressive in operating during the acute phase of myocardial infarction, between 6 and 10 hr following infarction. The time factor is crucial because reperfusion after this period may result in an extension of the infarction by haemorrhagic necrosis (Deloche *et al.*, 1972; Camilleri *et al.*, 1975).

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