Clinical significance, angiographic characteristics, and short-term outcomes in 30 patients with early coronary artery graft failure

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Background. **Despite technical advances in coronary artery bypass grafting (CABG), early postoperative myocardial ischaemia still remains a challenging problem. The aim of this study was to determine the incidence, clinical features, angiographic characteristics, and management of early graft failure in the present CABG era.**
Methods. **Between January 1997 and December 2002, 1731 patients underwent CABG at our institution. Coronary angiography was performed in patients with clinical evidence of early postoperative ischaemia (≤3 months). Thirty of these patients with graft failure constituted the population of this study.**
Results. **Off-pump and on-pump CABG were almost evenly performed in these patients [n=16 (53%) and n=14 (47%) respectively]. Acute myocardial infarction and unstable angina were the leading indications for coronary angiography in the majority of patients [n=28 (93%)]. The most common cause of graft failure was occlusion / thrombosis [n=20 (67%)]. Percutaneous coronary intervention (PCI) was offered to the majority of patients [n=22 (73%)]. Of these patients, 14 underwent PCI to native coronary arteries, whereas eight underwent PCI to the culprit vessel. Three patients underwent reoperation, and five received medical management. Four patients (13%) died in hospital (two after redo CABG, one after unsuccessful PCI, and one patient managed medically). Two patients (7%) had nonfatal major complications (one non-ST-elevation myocardial infarction and one stroke).**
Conclusion. **Early graft failure generally presents as acute coronary syndrome. Graft occlusion/thrombosis is the leading cause of ischaemia. Patients with graft failure can undergo PCI with a relatively low risk, but the need for redo CABG in associated with a high mortality. (*Neth Heart J* 2009;17:13-7.)**

Keywords: coronary graft failure, coronary angiography, post-CABG

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Despite technical advances in coronary artery bypass grafting (CABG), early postoperative complications are still associated with a significant in-hospital morbidity and mortality.[1-3] Furthermore, postoperative myocardial ischaemia has been linked to a decreased late survival.[2]

Coronary angiography has proven to be safe and precise to confirm early graft failure.[2,6] In addition, percutaneous coronary intervention (PCI) has yielded excellent results in this setting.[7-13]

With the recent changes in coronary surgery practice and advances in percutaneous coronary intervention (PCI), these complications may have different trends, features and outcomes.[3,4] The purpose of this study was to determine the incidence, clinical features, and angiographic characteristics of early graft failure in the present CABG era, and to assess the impact of procedural performance on short-term outcomes in patients undergoing PCI after early graft failure.

Methods

Patient selection

The analysis involved 30 patients who underwent coronary angiography at Jackson Memorial Hospital, University of Miami for early graft failure after CABG between 1 January 1997 and 31 December 2002. Patients were identified from the database of the Department of Cardiothoracic Surgery and cross-matched with the computerised Interventional Cardiology database.

Definitions

Early graft failure was defined as the need for coronary angiography in the first three months after CABG, for the following reasons: recurrent myocardial infarction (MI), recurrent symptoms of angina and/or objective evidence of myocardial ischaemia, recurrent or new-onset congestive heart failure, episodes of life-threatening ventricular arrhythmias and haemodynamic instability. Based on postoperative angiographic findings, the patients were classified as having technical lesions (anastomosis-related lesions, graft kink) or pathological lesions (thrombosis, graft spasm, and total graft occlusion).

Successful PCI was defined as final residual stenosis of <20% by visual estimation in the vessel intervened, with achievement of Thrombolysis In Myocardial Infarction (TIMI) grade 3 flow, without in-lab occurrence of death, recurrent MI, or a complication requiring emergency CABG.

Hospital death was defined as death occurring during the first 30 days after coronary angiography for evaluation of suspected early graft failure. Peri-procedural MI was defined as recurrent ischaemic symptoms or ECG changes with any CK-MB or troponin I re-elevation following PCI. Re-occlusion was defined as ≥90% stenosis and an abnormal TIMI flow in a recently intervened vessel.

Statistical analysis

Baseline characteristics and other categorical variables are presented as median, mean ± standard deviation, or as percentage of total patients in each group.

Table 1. Clinical characteristics of patients before CABG.

Clinical characteristics	Pathological lesions (n=23)	Technical lesions (n=7)	P
Age (mean/SD)	63.9/9.81	58.3/9.45	NS
Sex			
- Male, n (%)	11 (48)	5 (71)	NS
- Female, n (%)	12 (52)	2 (29)	NS
Angina			
- Stable, n (%)	2	2	NS
- Unstable, n (%)	11	6	NS
Myocardial infarction, n (%)	8	1	NS
Ejection fraction, mean/SD	47.6/7.37	52.1/6.36	NS
Diabetes, n (%)	14 (61)	2 (29)	NS
Current smoking, n (%)	10 (43)	4 (57)	NS
Hypertension, n (%)	14 (61)	6 (86)	NS
Hypercholestrolaemia, n (%)	5 (22%)	3 (43)	NS
PVD, n (%)	2 (9)	0	NS
CVD, n (%)	3 (13)	0	NS
Creatinine >2 mg/dl, n (%)	4 (17)	0	NS
Obesity, n (%)	2 (9)	0	NS
Prior MI, n (%)	4 (17)	1 (14)	NS
Prior PCI, n (%)	2 (9)	1 (14)	NS
Prior CABG, n (%)	1 (4)	0	NS
Extent of CAD			
- Single vessel, n (%)	1 (4)	1 (14)	NS
- Double vessel, n (%)	5 (22)	2 (29)	NS
- Triple vessel, n (%)	17 (74)	4 (57)	NS
IABP (≤48 hours pre-op), n (%)	1 (4)	0	NS

NS=not significant, SD=standard deviation, MI=myocardial infarction, PVD=peripheral vascular disease, CVD=cerebrovascular disease, PCI=percutaneous coronary intervention, CABG=coronary artery bypass grafting, CAD=coronary artery disease, IABP=intra-aortic balloon pump.

Differences between groups were evaluated by χ^2 test for discrete variables, and Student's t test for continuous variables. A p value ≤0.05 was considered statistically significant.

Results

Coronary angiography due to early postoperative ischaemia after CABG was performed in 30 patients (1.73%) out of a total of 1731 patients who underwent CABG. Twenty-three patients (77%) had pathological lesions whereas 7 (23%) had technical lesions. No differences in preoperative clinical characteristics between the two groups were found (table 1). Angiographic characteristics of the patients in these two groups before CABG are also listed in table 1. There were no significant differences in the extent of CAD between the two groups.

Perioperative characteristics between the groups are compared in table 2. There were no statistically significant differences when surgical factors such as emergency CABG, type and number of coronary grafts, total number of anastomosis, and need for postoperative intra-aortic balloon pump were compared. Although it did not reach statistical significance, patients with technical lesions underwent off-pump CABG more frequently (86% of patients with technical lesions) than patients with pathological lesions (43% of patients with pathological lesions, p=0.08).

Table 3 describes the indications for repeat coronary angiography after CABG. Most patients had recurrent ischaemia as the primary reason for repeat coronary angiography after CABG. Nonfatal acute myocardial infarction (AMI) occurred in 15 of the 23 patients with pathological lesions (65%) compared with one out of seven patients (14%) with technical lesions (p=0.03). Time to repeat angiography after CABG was significantly different in the two groups. The mean time was 19.2 days in patients with pathological lesions compared with 48.6 days in patients with technical lesions (p=0.01).

Table 2. Perioperative characteristics.

	Pathological lesions (n = 23)	Technical lesions (n = 7)	P
Emergency CABG, n (%)	5 (22)	0	NS
Off-pump CABG, n (%)	10 (43)	6 (86)	NS
On-pump CABG, n (%)	13 (57)	1 (14)	NS
Total number of grafts (mean/SD)	2.39/0.65	2.57/0.78	NS
Arterial grafts			
- LIMA, n (%)	20 (87)	6 (86)	
- RIMA, n (%)	0	1 (14)	NS
- Single target venous grafts	32	11	NS
- Multiple target venous grafts (jump grafts)	3	0	NS
Total number of anastomosis (mean/SD)	4.0/1.21	4.1/1.57	NS
Postoperative IABP, n (%)	3 (13)	0	NS

NS=not significant, CABG=coronary artery bypass grafting, SD=standard deviation, LIMA=left internal mammary artery, RIMA=right internal mammary artery, IABP=intra-aortic balloon pump.

Table 3. Indications for post-CABG angiography.

Indication	Pathological lesions (n = 23)	Technical lesions (n= 7)	p
Angina, n (%)	7 (30)	5 (71)	NS*
Myocardial infarction, n (%)	15 (65)	1 (14)	**0.03**
Congestive heart failure, n (%)	4 (17)	1 (14)	NS
Sustained ventricular arrhythmia, n (%)	2 (9)	0	NS
Haemodynamic instability, n (%)	2 (9)	0	NS
Days from CABG to angiography (mean/median)	19.2/7	48.6/42	**0.01**

* p=0.08, NS=not significant, CABG=coronary artery bypass grafting.

Table 4. Postoperative angiographic findings, management and outcomes.

	Pathological lesions (n = 23)	Technical lesions (n =7)	p
Angiographic findings			
- Incorrect anastomosis, n (%)	–	6 (86)	N/A
- Graft kink, n (%)	–	1 (14)	N/A
- Graft thrombosis/occlusion, n (%)	20 (87)	–	N/A
- Graft spasm, n (%)	1 (4)	–	N/A
- Multivessel lesions, n (%)	2 (8)	–	N/A
Management			
- Native arteries intervention, n (%)	13 (57)	1 (14)	NS*
- Graft intervention, n (%)	3 (13)	5 (71)	**0.001**
- Balloon angioplasty alone, n (%)	3 (13)	4 (57)	**0.03**
- Stent use, n (%)	14 (61)	2 (29)	NS
- Multivessel intervention, n (%)	1 (4)	0	NS
- Successful intervention, n (%)	15 (65)	6 (86)	NS
- Redo CABG, n (%)	3 (13)	0	NS
- Medical therapy, n (%)	4 (17)	1 (14)	NS
In-hospital outcomes			
- Death, n (%)	4# (17)	0	NS
- Myocardial infarction, n (%)	1 (4)	0	NS
- TVR, n (%)	0	0	NS
- Major bleeding, n (%)	0	0	NS
- Stroke, n (%)	1 (4)	0	NS
- Composite endpoints, n (%)	6 (26)	0	NS

* p=0.08, N/A=not applicable, NS=not significant, TVR=target vessel revascularisation. # This number includes two deaths after redo CABG, one after PCI, and one in a patient who was managed medically.

Table 4 shows the angiographic findings, management and outcomes of these 30 patients. Graft thrombosis/occlusion was the predominant angiographic finding among the pathological lesions (87%), whereas anastomosis-related lesions were the most frequent angiographic finding in the technical group (86%). Although native vessel intervention and stent use were both seen more often in patients with pathological lesions, these differences did not reach statistical significance. Conversely, graft interventions and PTCA alone were more frequently performed in patients with technical lesions (p=0.001 and 0.03, respectively). All major in-hospital adverse events (death, acute myocardial infarction, and stroke) occurred in the group of patients with pathological lesions. A total of four deaths (13%) occurred in the entire cohort of patients. There were two deaths in patients who underwent redo-CABG, one death in the PCI group that occurred shortly after a complicated native vessel stent deployment, and one death in a patient managed medically.

Discussion

There are multiple important findings of clinical interest in this series of consecutive patients with early graft failure after CABG. First, pathological graft lesions occurred earlier than the technical lesions. Second, recurrent postoperative ischaemia was the leading mode of presentation of early graft failure. Third, when pathological lesions occurred, the native arterial system was often the primary PCI target; when technical lesions occurred, the culprit graft vessel was commonly the primary PCI target. Fourth, the total in-hospital mortality rate was 13%, and it was exclusively observed in patients with pathological graft failures.

Previous studies have reported that the incidence of perioperative ischaemia is 3.5 to 6.4% in patients undergoing CABG.[1,2] However, the true incidence may have been underestimated because some of the patients in this clinical setting die soon after surgery before coronary angiography can be performed. The lower incidence of early perioperative ischaemia in our study (1.73%) is perhaps related to the presence of a lower risk population in our study, the underdiagnosis of this condition, incomplete referral of diagnosed patients for repeat coronary angiography, and the tendency of taking sicker and haemodynamically unstable patients back to the operating room without performing coronary angiography in the first few days after CABG.

Clinical presentation of early graft failure is dominated by postoperative myocardial ischaemia, but also includes left ventricular dysfunction, life-threatening

ventricular arrhythmias and haemodynamic instability.[2,3,5] In the present study, myocardial ischaemia was again the predominant clinical presentation. Myocardial infarction was the leading ischaemic condition in the group of patients with pathological graft lesions and was significantly more common than in those with technical lesions.

As previously noted, our study found that recurrent ischaemia due to pathological graft lesions occurred earlier than that caused by technical lesions (p=0.01). Most patients with pathological lesions had subtotal or total occlusion of the grafts compared with patients with technical lesions (data not shown). This may explain the differences in clinical presentation (earlier postoperative symptoms) and outcomes (higher number of adverse events) in patients with pathological lesions.

The ability to differentiate graft failure due to pathological lesions from technical lesions is important for patient care, because a proper and timely diagnosis will help in selecting the appropriate therapy and promote more accurate determination of prognosis. Prior studies have demonstrated that early postoperative angiography in patients suspected of having graft failure is safe, feasible and provides a precise anatomic diagnosis that enables early treatment and salvage of myocardium.[2,6] Our study corroborates these findings. PCI for graft failure has yielded favourable results.[7-14] In a study of 45 patients, early angioplasty to relieve myocardial ischaemia was reported at a mean of 49 days after CABG; the intervention was successful in 95% of native artery lesions (n=46), and 100% of LIMA graft lesions (n=11).[8] Likewise, PCI with stenting of both the native arterial system and the coronary grafts has been successfully used to treat perioperative ischaemia.[3,13,14] The use of PCI in our case series has also yielded rewarding results. In concordance with the current interventional practice, PCI of native coronary vessels was the revascularisation method of choice when pathological graft lesions were found (p=0.08); conversely PCI of the culprit graft was usually the preferred interventional procedure when technical lesions were encountered.

Patients with early graft failure are at significant risk of in-hospital adverse events. Previous studies have reported a high mortality rate, ranging from 14.5%[6] to 21.7%[3] and a substantial rate of nonfatal complications.[2,6] Likewise, we found an overall high mortality rate (13%), which was mainly driven by a remarkable occurrence of fatal events in the patients with pathological graft lesions requiring redo CABG. These patients had severe coronary artery disease and a labile haemodynamic status at the time of surgery. Compared with redo CABG, PCI appears to be the preferred treatment strategy in patients with early graft failure.

Limitations

Our study has limitations. The primary limitation of this study is that it is a single centre, retrospective analysis of a small group of patients. Thus, our results may not be generalised to other centres. Patient selection and referral bias are important limitations as the study was conducted at a large tertiary care hospital. Additionally, some cases of pathological graft failures may have been due to an initial technical failure. This may have lead to an underestimation of the total number of technical lesions and an overestimation of pathological graft failures.

Conclusion

With above-mentioned limitations of our study, early graft failure carries a significant morbidity and mortality after CABG. Patients with pathological graft lesions in our series tend to have an earlier occurrence of myocardial ischaemia. Coronary angiography is useful to provide diagnosis, identify the cause of graft failure and guide further management. Patients with graft failure can undergo PCI with a relatively low risk. ■

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