

Angiographic Control and Percutaneous Treatment of Myocardial Ischemia Immediately after CABG

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ABSTRACT

Perioperative myocardial ischemia is rare but serious complication of CABG. Graft dysfunction, coronary artery thrombosis and incomplete revascularization are main causes. Pharmacological treatment, intra aortic counter pulsation and immediate additional grafting have limited results. Treatment strategy based on coronary angiography findings could lessen the burden of high mortality rate in these patients. The purpose of this study was to analyze the causes of perioperative ischemia and angiography based treatment strategy including percutaneous intervention. We enrolled all 55 consecutive patients that went early coronary angiography for perioperative myocardial ischemia in a prospective longitudinal study. Incorrect graft anastomosis, graft spasm, displacement and dissection were found in 49%, 7%, 5% and 4% of patients, respectively. Acute coronary artery thrombotic occlusion was found in 5% of patients and ischemia due to incomplete revascularization in 6% of patients. In 22% of patients no cause of myocardial ischemia could be detected. There were no complications of coronary angiography. Based on coronary angiography findings percutaneous intervention was performed in 30 patients, additional grafting in 8 patients and no action was taken in 17 patients. Percutaneous intervention with stenting was performed on coronary arteries (78%) and graft anastomosis (22%) with primary success 97%. One anastomosis rupture with treatable tamponade and one lethal stent thrombosis were complications of percutaneous treatment. Overall in hospital mortality was 30%. We concluded that graft dysfunction is usual cause of myocardial ischemia due to incorrect anastomosis and that percutaneous intervention on bypass graft or coronary artery can lessen high mortality rate in these patients.

Key words: coronary artery bypass graft, percutaneous coronary intervention, stent, perioperative ischemia, clinical outcome

Introduction

Coronary artery bypass grafting (CABG) is safe and successful treatment of coronary artery disease with perioperative mortality usually less than 1%. Acute myocardial ischemia, acute heart failure, excessive bleeding and hospital infection are potentially lethal complications.

Perioperative myocardial ischemia is rare but serious complication of CABG resulting in acute myocardial infarction, heart failure and cardiac arrest due to ventricular tachycardia and fibrillation (VT/VF). Common causes of perioperative ischemia are dysfunction of bypass graft due to incorrect coronary artery anastomosis, graft displacement, stenosis, occlusion or spasm and incomplete revascularization¹.

Perioperative ischemia is suspected in hemodynamic deterioration usually with ST segment elevation or depression. Ventricular tachycardia and ventricular fibrillation in these patients are usually caused by myocardial ischemia. Increase in of creatinine phosphokinase isoenzyme ratio and cardiac troponin clearly identifies myocardial necrosis. If the patients are haemodynamically severely compromised, additional bypass grafting is performed immediately in the operating room². Other patients are treated with inotropic drugs and intraaortic counter pulsation with limited success.

Coronary angiography performed immediately or early after CABG can be reliable method in determining

the cause of myocardial ischemia³. Additional bypass grafting or percutaneous intervention can be performed based on these findings. Percutaneous intervention on coronary arteries can ensure adequate myocardial perfusion replacing the dysfunctional bypass graft. Bypass graft and coronary artery anastomosis stent implantation is also proved to be safe and effective in these bail-out situations⁴.

Finding the cause of perioperative myocardial ischemia and completing the revascularization could improve survival of these patients.

Objectives of this study were to determine causes of perioperative myocardial ischemia and to assess safety and efficacy of coronary angiography and percutaneous interventions immediately after CABG.

Patients and Methods

Between 1999 and 2009, 3,000 patients were treated in our hospital with CABG for coronary artery disease. We included all 55 consecutive patients that met criteria for perioperative ischemia and underwent early coronary angiography.

Inclusion criteria were haemodynamical deterioration, new ST segment depression or elevation greater than 1 mm, isoenzyme ratio of creatinine phosphokinase greater than 0.1, cardiac troponin greater than 0.1 mmol/L,

sustained ventricular tachycardia, repeated nonsustained ventricular tachycardia and ventricular fibrillation. We excluded all patients that did not go early coronary angiography. Patient characteristics are listed in Table 1.

Two groups of patients were identified (Figure 1). Patients with severe haemodynamical instability were treated immediately with additional bypass grafting. If myocardial ischemia persisted coronary angiography was performed. Coronary angiography was performed immediately in all patients without haemodynamical instability.

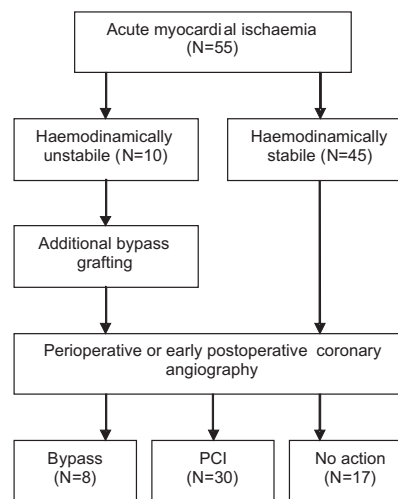


Fig. 1. Treatment strategy. Pci = percutaneous coronary intervention.

TABLE 1
PATIENTS CHARACTERISTICS

	No. of patients	%
Age		
<50 y	7	13
50–70 y	32	58
>70 y	17	31
Sex		
Male	41	75
Female	15	25
Diabetes	18	33
Coronary artery disease		
Prior MI	22	40
Prior PCI	14	25
Left main stenosis	23	42
Triple vessel disease	35	64
CABG		
Urgent	24	44
Elective	31	56
IABP	42	76
Off-pump	29	53

MI = myocardial infarction, PCI = percutaneous coronary intervention, CABG = coronary artery bypass graft, IABP = intra-aortic balloon pump.

After coronary angiography all were treated the same way. Additional bypass grafting, percutaneous intervention with stent implantation or standard pharmacological support were different treatment strategies depending on coronary angiography findings.

Continuous variables were presented as medians (range) and categorical data presented by their actual number and summarized as percentages.

Results

Persistent perioperative and early postoperative ischemia were indications for early coronary angiography after CABG in 55 patients out of 3,000 (1.8%). More than 30% of patients were octogenarians, dominantly males, and 33% were diabetics. Left main stenosis and triple vessel disease were usual indications for CABG. High rate of urgent indications for CABG (N=24, 44%) was noted in this group of patients as well as off-pump operations.

Patients with severe haemodynamical deterioration after CABG underwent immediate additional bypass grafting (N=10, 18%), while coronary angiography was performed immediately in haemodynamically stable patients (N=45, 82%). No complications of coronary angiography were identified.

TABLE 2
CORONARY ANGIOGRAPHY FINDINGS

	No. of patients	%
Graft dysfunction	36	65
Incorrect anastomosis	27	49
Graft spasm	4	7
Graft dissection	2	4
Graft displacement	3	5
Partial revascularisation	4	6
Acute thrombotic occlusion of coronary artery	3	5
No obstruction	12	22

Graft dysfunction was common cause of myocardial ischemia (N=36, 65%), predominantly due to incorrect coronary artery anastomosis (N=27, 49%, Table 2). Graft dysfunction due to displacement, spasm or dissection, coronary artery thrombosis and incomplete revascularization were also responsible for ischemia. In 12 patients (22%) no cause of myocardial ischemia was detected.

Coronary angiography was performed in all patients with persistent myocardial ischemia after additional bypass grafting (N=10, 18%). Additional grafts were often found to be dysfunctional (N=5, 50%). PCI with stent implantation was performed in 30 patients (55%), additional bypass grafting or graft anastomosis resuturing in 8 patients (15%) and no action was taken in 17 (31%) of all patients.

Percutaneous interventions were performed dominantly on coronary arteries, but also on distal graft anastomosis with the success rate 97% (Table 3). Major complications of PCI were detected in two patients: coronary artery rupture with tamponade that was successfully treated and acute stent thrombosis with lethal outcome. Overall in hospital mortality was 24% (N=13). One patient died during bail-out percutaneous intervention.

Discussion

The risk profile of study patients did not differ significantly from the profile found in typical Croatian coronary patients^{5,6}. Early identification of potential complications of cardiovascular procedures has been shown to be extremely useful in improving outcome of these patients⁷⁻⁹. Perioperative ischemia is a rare complication of CABG with high mortality rate. There is no sufficient data on treatment strategies for these patients. However, usual conservative approach does not seem to be successful in eliminating the cause of myocardial ischemia. Additional LAD bypass grafting without previously verifying cause of myocardial ischemia can stabilize the patient, but is rarely definitive treatment. Urgent perioperative coronary angiography seems to be safe and useful in determining the cause of ischemia and results in appropriate treatment strategy.

TABLE 3
RESULTS OF PERCUTANEOUS CORONARY INTERVENTION

	No. of patients	%
PCI	37	67
LMCA	7	13
LAD	9	16
RCA	9	16
CxA	4	7
Graft	8	15
Primary success	36	97
In-hospital mortality	9	30

PCI = percutaneous coronary intervention.

However, there are several problems with this approach. Diagnosis of myocardial ischemia is difficult to confirm. Changes of ST segment in ECG after myocardial revascularization have low specificity and sensitivity. Increase in myocardial necrosis markers is often present without ongoing ischemia due to heart injury during operation. Haemodynamic instability and ventricular arrhythmia can be caused by many other factors after operation. In this study specificity was high. Therefore, some cases of perioperative myocardial ischemia were probably missed.

The association between myocardial ischemia and coronary angiography findings in these settings is sometimes hard to interpret. One study found significant number of unexpected arterial graft occlusions without signs of ischemia when coronary angiography was performed routinely after CABG¹⁰. Transient graft spasm could explain angiography findings in these patients since occlusion was found in only few patients at reoperation. Another group of authors found that most graft stenosis visualized on routine early coronary angiography could not be found after few months¹¹. However, both studies enrolled only patients without any sign of ischemia.

Results of this study showed that myocardial ischemia is usually caused by incorrect coronary artery anastomosis. This may well be related to surgical expertise. Incorrect indications for CABG in the setting where coronary artery is located intramural, and therefore impossible to bypass, must be avoided.

Because perioperative ischemia is a rather rare complication of CABG that requires bail-out treatment, there are no randomized studies confirming superiority of invasive strategy. However, PCI seems to be safe and successful treatment completing myocardial revascularization. Stenting of coronary arteries is usually preferred approach probably because it is easier and with fewer complications. Stenting graft anastomosis seems to be safe. It was complicated with partial graft rupture and treatable tamponade in 1 patient out of 8 (13%). However, the question remains whether it is only reversible graft spasm or incorrect anastomosis. Partial revascularization is another cause of ischemia that can be resolved with additional stenting.

Higher rate of acute PCI complications such as stent thrombosis, coronary artery perforation or rupture and stroke are expected. High mortality rate in these patients is also not surprising. Random selection of patients receiving only pharmacological treatment would be unethical. Therefore, only observational study is possible. The number of patients included is rather small, and gathering results from multiple centers would give more accurate conclusions.

Conclusions

1. Perioperative and early postoperative ischemia is rare complication of CABG.

2. Graft dysfunction is usual cause of myocardial ischemia due to incorrect anastomosis.
3. Coronary angiography is safe and effective in determining the cause of myocardial ischemia and treatment strategy.
4. Additional bypass grafting is often ineffective in resolving myocardial ischemia.
5. Percutaneous intervention on bypass graft or coronary artery in the setting of perioperative myocardial ischemia is found to be safe and successful treatment.
6. Mortality rate in these high risk patients is as would be expected.
7. Further studies are needed to determine clinical benefit and cost effectiveness.

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KONTROLNA KORONAROGRAFIJA I PERKUTANA INTERVENCIJA ZBOG ISHEMIJE MIOKARDA NEPOSREDNO NAKON CABG

SAŽETAK

Perioperativna ishemija miokarda je rijetka, ali ozbiljna komplikacija aortokoronarnog premoštenja. Najčešći uzroci su disfunkcija grafta, tromboza koronarne aretrije i inkompletna revaskularizacija. Farmakološko liječenje, postavljanje intra aortne kontrapulzacije i dodatne venske prenosnice imaju ograničene rezultate. Strategija liječenja temeljena na nalazu koronarografije mogla bi smanjiti visoki mortalitet ovih bolesnika. Namjera ove studije bila je analizirati uzroke perioperativne ishemije i uspješnost strategije liječenja temeljene na ranoj koronarografiji uključujući perkutane intervencije. Uključeno je 55 konsekutivnih bolesnika kojima je učinjena rana koronarografija zbog perioperativne ishemije kod aortokoronarnog premoštenja. Nefunkcionalna anastomoza prenosnice pronađena je kod 49% bolesnika, spazam prenosnice kod 7%, disekcija kod 4%, a anastomoza na pogrešnom mjestu kod 5% bolesnika. Trombotska okluzija koronarne arterije bila je odgovorna za ishemiju miokarda kod 5%, a inkompletna revaskularizacija kod 6% bolesnika. Kod 22% bolesnika nije nađen uzrok ishemije. Nisu zabilježene komplikacije koronarografije. Perkutana intervencija je učinjena kod 30 bolesnika, postavljanje dodatne venske prenosnice kod 8 bolesnika, a ostali bolesnici su liječeni konzervativno. Perkutane intervencije s postavljanjem stenta su učinjene na koronarnim arterijama (78%) i na anastomozama prenosnica (22%) s 97% primarnim uspjehom. Perkutane intervencije komplicirane su jednom tamponadom uslijed rupture anastomoze koja je uspješno liječena i jednom trombozom u stentu sa smrtnim ishodom. Ukupna intrahospitalna smrtnost bila je 30%. Zaključili smo da je najčešći uzrok perioperativne ishemije miokarda disfunkcija prenosnice uslijed nefunkcionalne anastomoze i da se perkutanom intervencijom na prenosnici ili na koronarnoj arteriji može smanjiti visoki mortalitet ovih bolesnika.