Emergency invasive intervention in the diagnosis and treatment of perioperative ischaemia in patients undergoing coronary surgery

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Abstract

Introduce: Perioperative myocardial infarction after surgical coronary artery revascularization is an important diagnostic and therapeutic issue. Urgent coronary and bypass angiography is a relatively new strategy, but there are few publications on this subject.

Aim: The aim of this study is to present the results of urgent diagnostic angiography and percutaneous interventions in patients with symptoms of acute myocardial ischaemia during the first 24 hours after coronary artery bypass graft surgery.

Material and Methods: The study group comprised 153 (1.38%) among 11 090 patients who underwent coronary artery surgery. They underwent early coronary and bypass angiography due to the symptoms of acute myocardial ischaemia.

Results: On the basis of angiography percutaneous intervention was performed in 62 (40.5%) pts, including balloon angioplasty of native artery or bypass in 23 (37.1%) pts and 39 (62.9%) pts had angioplasty with stent implantation. In 30 (19.6%) cases angiography revealed no new lesions in native arteries or grafts. 42 (27.4%) pts were qualified for conservative therapy, because of lack of technical possibilities for PCI or reoperation. Surgical reintervention was needed in only 25 (16.3%) pts.

Conclusions: The diagnostic and therapeutic strategy of urgent angiography of coronary arteries and grafts in the event of perioperative ischaemia after coronary artery surgery (in the first 24 hours after operation) allows the precise diagnosis and establishment of optimal management. In more than 40% of pts percutaneous intervention is possible with a high success rate (above 85%). 80% of patients with acute perioperative ischaemia can avoid reoperation and those referred for repeat cardiac surgery had established indications and the range of reintervention.

Key words: coronary artery bypass graft, perioperative ischemia, coronary angiography.

Streszczenie

Wstęp: Wystąpienie zawału śródoperacyjnego w przebiegu pomostowania tętnic wieńcowych stanowi istotny problem zarówno diagnostyczny, jak i leczniczy. Postępowanie polegające na wczesnej pilnej koronarografii i bajpasografii jest postępowaniem stosunkowo nowym, a analizy dotyczące tego zagadnienia są nieliczne.

Cel: Celem pracy jest przedstawienie wyników strategii pilnej diagnostyki i interwencji przezskórnej u chorych z cechami ostrego niedokrwienia mięśnia sercowego, które występują w pierwszych 24 godzinach od operacji pomostowania tętnic wieńcowych.

Materiał i metody: Badaną grupę stanowiło 11 090 chorych poddanych chirurgicznej rewaskularyzacji, spośród których u 153 (1,38%) wykonano pilną koronarografię i bajpasografię z powodu objawów ostrego niedokrwienia mięśnia sercowego. Na podstawie ich wyniku decyzję o leczeniu przezskórnym podjęto u 62 (40,5%) pacjentów, w tym u 23 (37,1%) wykonano angioplastykę balonową pomostów lub tętnic natywnych, natomiast angioplastykę z implantacja stentu/stentów u 39 (62,9%) chorych. W 30 (19,6%) przypadkach koronarografia pozwoliła na wykluczenie nowych zmian w tętnicach natywnych lub pomostach, natomiast u 42 (27,4%) chorych zdecydowano o leczeniu zachowawczym, czego powodem był brak możliwości technicznych wykonania rewaskularyzacji przezskórnej lub reperacji. Jedynie 25 chorych, co stanowi 16,3% analizowanej grupy, wymagało skierowania do rewizji chirurgicznej.

Wnioski: Strategia diagnostyczno-lecznicza polegająca na pilnej koronarografii i bajpasografii w sytuacji wystąpienia objawów niedokrwienia mięśnia sercowego w okresie okołooperacyjnym umożliwia określenie przyczyny ostrego niedokrwienia oraz ustalenie optymalnego sposobu postępowania. U ponad 40% chorych możliwe jest wykonanie interwencji przezskórnej, której skuteczność wynosi ponad 85%. Taki sposób postępowania powoduje, że 4 na 5 chorych unika ponownej operacji, a ci, którzy są na nią kierowani, mają ustalone wskazania i zakres reinterwencji.

Słowa kluczowe: pomostowanie aortalno-wieńcowe, niedokrwienie okołooperacyjne, koronarografia.

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Introduce

The perioperative myocardial infarction rate in coronary surgery ranges from 3.5% to 30%, according to different authors [1-4]. There is no consensus on its prognostic value either. Perioperative infarction is said to significantly increase early mortality and worsen long-term prognosis [1-3]. On the other hand there are opinions that it only prolongs the intensive care unit stay, not affecting prognosis and late mortality [4-6]. In-hospital mortality ranges from 9.1% to 68% [1, 2]. This is due to different diagnostic criteria of perioperative ischaemia, different operative risk in cardiac surgery patients and different treatment strategies [3-10]. Emergency early coronary bypass and native vessel angiography is a relatively new strategy, not frequently confirmed in the literature [1, 2]. Perioperative infarction should be referred to as a new onset of acute ischaemia, with determined myocardial territory, accompanied by new local contractility impairment and significant increase in myocardial necrotic markers. According to the new definition, myocardial infarction after coronary artery bypass grafting is recognized in the case of a fivefold increase in concentration of biomarkers above the upper reference range and/or occurrence of a new pathological Q wave or onset of new left bundle branch block (LBBB) or angiographically confirmed acute occlusion of native artery or graft or loss of myocardial viability seen in imaging studies [12]. Risk factors of perioperative infarction can be either stable, with no possibility of modification, for example multi-vessel, diffused coronary lesions, poor collaterals, small calibre of grafted vessels, history of infarction and/or surgical revascularization, impaired left ventricle systolic function, and advanced age, or may be prone to modification, for example surgery in acute ischaemia (especially with elevated myocardial necrotic markers), heart failure, incomplete revascularization, and long cardio-pulmonary bypass time [13]. It is crucial to achieve haemodynamic stability by means of pharmacological agents preoperatively, and in patients with acute coronary syndrome surgical treatment should be, if possible, postponed until troponin level is normal. Special care should be taken to achieve minimal length of surgery and cardiopulmonary bypass time and optimal myocardial protection during the procedure [14]. The aim of the study is to discuss the results of early percutaneous intervention in patients with acute myocardial ischaemia within 24 hrs after surgical revascularization.

Material and Methods

Between 01.01.2000 and 31.10.2008, 11 090 patients underwent surgical revascularization at the Department of Cardiac Surgery in the Silesian Centre for Heart Diseases in Zabrze. 6700 (60.4%) were operated on with the use of cardiopulmonary bypass (CABG), 2720 (24.5%) off pump (OPCAB), 214 (1.9%) with a less invasive approach (MIDCAB, TECAB), and 1456 (13.1%) underwent a combined procedure (including surgical correction of ischaemic valve disease or left ventricle reconstruction [SVR]). Acute myocardial ischaemia within 24 hrs after the procedure occurred in 153 patients (1.38%). Urgent angiography was performed in these patients in order to find the cause of ischaemia. Acute perioperative ischaemia was recognized in the case of the following changes in standard 12-lead ECG: ST segment elevation or depression, > 1.0 mm in the two continuous adjacent leads, new left bundle branch block, complex ventricular arrhythmia (sustained ventricular tachycardia, ventricular fibrillation), and also in the case of cardiogenic shock. The biochemical criteria were fivefold increase over the upper reference range of CKMB or troponin T in the first 24 hrs. The angiography was done mainly by femoral access (the radial artery was used in two cases). Coronary arteries and grafts were viewed in standard projections (in additional ones according to the operator). 50% lesion was referred to as significant. Coronary flow was assessed according to TIMI (Thrombolysis In Myocardial Infarction) classification. The following causes of ischaemia were recognized by means of angiography: thrombus, organic lesion (native artery/graft narrowing or occlusion), spasm, flow disturbances, size discrepancy between native artery and graft, incorrect anastomosis. In some patients angiography did not reveal any abnormalities. Left ventricle ejection fraction (LVEF), before surgery and perioperatively, was estimated routinely by echocardiography. Perioperative myocardial infarction was recognized in the case of ECG changes: new Q waves longer than 40 ms in more than one lead or R wave reduction in at least two adjacent leads or lasting negative T wave with negative phase over 1.0 mm with simultaneous reduction of LVEF and new local contractility disturbances and significant increase of myocardial necrotic markers. In our group necrotic markers (CK-MB activity, CK-MB mass, troponin T or I) were used to assess the myocardial damage, not to qualify for urgent intervention. According to the European Cardiac Society myocardial infarction after cardiac surgery can be recognized, no matter what the cause, with over tenfold increase of necrotic markers [12].

Statistical analysis

Quantitative data are presented as mean values ± standard deviation. If normal distribution was not seen, median and quartiles were used. Qualitative data are presented as percentages.

Results

Population characteristics (Table I). There were 50 (32.7%) females and 103 (67.3%) males. The age range was 33-79 yrs (median 62.0; mean 59.7 ± 9.8). 90 (58.8%) patients had a history of myocardial infarction, 46 (30.1%) patients had a history of percutaneous coronary intervention: balloon angioplasty in 11 (7.2%) cases, stent implantation in 35 (22.9%) cases. The incidence of atherosclerosis risk factors was as follows: systemic hypertension in 101 (66.0%) patients, type 2 diabetes mellitus in 41 (26.8%), hyperlipidaemia in 121 (79.1%), obesity (BMI > 30) in 45 (29.4%), active smoking in 60 (39.2%). Peripheral vascular disease was observed in 32 (20.9%) patients, chronic obstructive pulmonary disease in 9 (5.9%). Angina was classified ac-

Tab. I. Clinical characteristics of the population

Clinical variable	Patients with acute ischaemia undergoing emergency angiography (n=153)
Age (yrs)	59.7±9.8
Male	103 (67.3%)
History of MI	90 (58.8%)
History of PCI	46 (30.1%)
History of CABG	2 (1.3%)
Systemic hypertension	101 (66.0%)
Type 2 diabetes mellitus	41 (26.8%)
Hyperlipidaemia	131 (79.1%)
Obesity	45 (29.4%)
Smoking	60 (39.2%)
Peripheral vascular disease	32 (20.9%)
Chronic obstructive pulmonary disease	9 (5.9%)
CCS class: - I, - II, - III, - IV	 15 (9.8%) 55 (36.0%) 48 (31.3%) 35 (22.9%)
LVEF	50.5±7.8%
Coronary artery disease: - single vessel, - two vessel, - multi-vessel, - left main disease	 27 (17.6%) 31 (20.3%) 95 (62.1%) 44 (28.7%)

CABG – coronary artery bypass grafting; CCS – Canadian Cardiovascular Society; LVEF – left ventricle ejection fraction; LM – left main; MI – myocardial infarction; PCI – percutaneous coronary intervention.

Tab. II. Angiographic data

No changes	30 (19.6%)
Graft occlusion	37 (24.4%)
Graft narrowing	23 (18.7%)
New occlusion of native artery	11 (8.9%)
Narrowing of native artery	8 (6.5%)
Occlusion/narrowing of native artery and graft implanted in it	23 (18.7%)
Delayed flow in native arteries/grafts	6 (4.9%)
Incorrect anastomosis	2 (1.6%)
Native artery/graft spasm	11 (8.9%)
Poor run-off	9 (7.3%)

cording to the Canadian Cardiac Society (CCS). 15 (9.8%) patients were in class I, 55 (36.0%) in class II, 48 (31.3%) in class III, 35 (22.9%) in class IV. As for pharmacotherapy directly before surgery 139 (90.8%) patients were treated with nitrates, 133 (86.9%) with β-blockers, 74 (48.4%) with ASA (in elective cases the therapy was usually discontinued 5-7 days before surgery), 103 (67.3%) with an ACE inhibitor, 27 (17.6%) with a calcium channel inhibitor, 70 (45.7%) with statins. Additionally, unfractionated heparin was applied in 21 (13.7%) cases and low molecular weight heparin in 23 (15.0%) cases. The mean value of LVEF in echo scan was 50.5 ± 7.8%. In angiography multi-vessel disease was diagnosed in 95 (62.1%) patients, two vessel disease in 31 (20.3%), single vessel disease in 27 (17.6%). Left main disease was observed in 44 (28.7%) cases.

Surgical data

73 (43.7%) patients underwent on-pump surgery (CABG and combined procedures), 38 (24.8%) off-pump surgery (OPCAB) and 42 (27.5%) a less invasive procedure (MIDCAB or TECAB). The total number of grafts was 343, including 150 (43.7%) arterial ones. The arterial conduits were: left interior thoracic artery (LITA) to left anterior descending artery (LAD) and/or first diagonal artery (D1) – 142, right interior thoracic artery (RITA) to right coronary artery (RCA) – 1, radial artery (RA) – 6, including 1 jumping graft RA-D1-OM1 (first obtuse marginal branch). The number of vein grafts was 196 (56.3%), including 11 jumping grafts. Incomplete revascularization was done in 27 (17.6%) patients: 10 (13.7%) in 73 on-pump cases, 13 (34.2%) in OPCAB cases and 4 (9.5%) in 42 MIDCAB and TECAB patients. The mean number of grafts was 2.2 ± 1.1 per patient. All patients underwent angiography within the first 24 hrs after the surgical procedure due to acute myocardial ischaemia. The median time between admission to the postoperative intensive care unit and the beginning of ischaemia was 1.6 hrs (25-75%: 0.2-8.0).

Electrocardiographic changes

ECG abnormalities were presented by Pardee type ST elevation in 100 (65.4%) patients, other types of ST elevation in 39 (25.5%), ST depression in 12 (7.8%). Other types of ECG changes were observed in 2 (1.3%) cases (negative T wave, new left bundle branch block). Acute ischaemia in ECG concerned the anterior or antero-lateral wall in 95 (62.1%) patients, inferior or lateral or infero-lateral wall in 58 (37%) cases. Additionally in 22 (14.4%) patients serious ventricular arrhythmia occurred (VT, VF) and in 4 (2.6%) patients atrioventricular block requiring temporary stimulation was observed.

Angiographic data

Angiographic abnormalities included acute occlusion caused by thrombus, significant graft narrowing resulting in malperfusion of supplied myocardial territory, native artery/graft spasm. In 30 (19.6%) cases normal anatomy and function of implanted grafts was seen. In 24 (15.6%) patients acute ischaemia was due to incomplete surgical revascularization and concerned ungraftable, diseased coronary vessels.

Angiography resulted in percutaneous intervention in 62 (40.5%) patients. Balloon angioplasty was done in 41 native arteries and 19 grafts. Stent implantation was done in 34 arteries and 13 grafts (bare metal stents in all cases). Complex percutaneous intervention (involving more than

one vessel or graft) was performed in 14.5% (9/62) of cases. In conclusion, 23 (46.9%) patients underwent balloon angioplasty of a graft or native artery and 26 (53.1%) underwent angioplasty with stent implantation (mean 1.3 ± 0.5 stents per patient). Efficacy of PCI understood as TIMI 3 flow or residual narrowing less than 50% was achieved in 53 (85.5%) patients. 48 (31.4%) patients required intra-aortic balloon counterpulsation. Angiography led to the decision of emergency surgery in 25 (16.3%) patients, including 5 (3.2%) after failed percutaneous intervention. 29 (18.9%) patients developed cardiogenic shock; 16 (10.4%) of them required reoperation. 72 (47.0%) patients were referred for conservative treatment, either because there were no changes in native vessels/grafts (30/19.6%) or because both reoperation and percutaneous intervention were impossible for technical reasons (small calibre of vessels, atherosclerotic aorta, size discrepancy between native artery and graft, tortuous vessels), which was the case in 42 (27.4%) patients. Routine necrotic markers were CK-MB mass and/or troponin T. The median CK-MB mass was 63.5 ng/ml (25-75%: 32.0-125.5 ng/ml). Troponin T concentration ranged from 0.01 to 85.0 ng/ml, and the median was 2.54 ng/ml (25%-75%: 0.82-9.63 ng/ml). According to ECG changes, angiographic abnormalities and myocardial necrotic marker concentrations, perioperative myocardial infarction was diagnosed in 102 (66.0%) patients. 13 (8.5%) patients died. The mean value of pre-discharge left ventricle ejection fraction as assessed by echo scan was 41.2 ± 10.4%. When compared to the ejection fraction on admission, the impairment of contractility was significant ($p < 0.05$).

Discussion

Acute myocardial ischaemia early after surgical revascularization presents a serious clinical problem. It may result in myocardial infarction and increase in morbidity postoperatively and in long-term follow-up. It is usually associated with longer intensive care unit stay [1-3]. The perioperative infarction rate in cardiac surgery ranges, according to different authors, from 3.5% to 30.0% [1-4]. There is much bias in early mortality data ranging from 9.1% to 68.0% [1-3]. There is not much literature on this subject. There is also a lack of criteria of perioperative ischaemia, perioperative infarction and standards of their treatment. Reports on emergency angiography and invasive treatment are quite rare. There are two outstanding papers regarding this issue.

Rasmussen et al. [1] reported on the results of treatment in 71 patients (of 2003 undergoing coronary artery bypass grafting) suffering from acute perioperative ischaemia, in five-year follow-up. Urgent angiography, followed by invasive treatment, was done in 59 cases. 12 patients were reoperated on an emergency basis. The diagnostic trigger of early re-intervention was increased activity of creatinine kinase MB fraction, higher than 80.0 IU/l, accompanied by ST changes, a new Q wave and additionally electric and/or haemodynamic instability. Patients with unstable haemodynamics were referred for emergency redo surgery. The angiographic changes included graft narrowing/occlusion, incorrect anastomosis, impaired peripheral flow and incomplete revascularization. Some of them underwent emergency reoperation. Perioperative infarction was recognized in 67%; 30-day mortality was 7.0%. In the emergency surgery group the main reason was graft occlusion; 30-day mortality was 50.0%.

Fabricius et al. [2] reported on 131 patients with perioperative ischaemia (6.4% of 2052 patients undergoing surgical revascularization within 12 months). Early invasive diagnostics was applied in 108 cases. Emergency surgery without angiographic guidance was done in 23 patients. The diagnostic criterion was again increased activity of CK-MB (> 50.0 IU/l), abnormal relation of total CPK activity and CK-MB activity (higher than 10%, observed in most patients), typical ischaemic ECG changes (at least 1.0 mm ST changes, new Q wave), complex ventricular arrhythmia, cardiogenic shock. Angiography revealed graft occlusion or narrowing, incorrect anastomosis, spasm, impaired peripheral flow and in some cases no new lesions. In some patients ischaemia was caused by incomplete revascularization. Angiography was decisive for treatment choice: either reoperation (most frequently) or angioplasty. If the intervention was impossible because of poor quality vessels, conservative treatment was applied. In the case of reoperation without angiography the causes of ischaemia were graft occlusion, incorrect anastomosis, incorrect graft positioning, tied graft, and graft spasm. In a few cases no abnormality was found. Patients who underwent angiography for reintervention choice presented significantly lower mortality in 30-day follow-up. It is possible that worse results of surgery without previous angiography were caused by preoperative clinical deterioration leaving no time for angiographic assessment.

Urgent angiography was possible whenever acute ischaemia appeared. It allowed the cause of ischaemia to be found and the optimal strategy to restore myocardial perfusion to be chosen. Percutaneous intervention usually helped to avoid high risk surgery. In other cases angiography could precisely define the target of surgical intervention. This method could also diagnose ischaemia caused by vascular spasm or impaired microperfusion despite normal flow in native arteries or grafts. Thanks to this strategy 4 of 5 patients can avoid redo surgery. In case of reoperation indication and extent of surgery are well determined.

Our experience helped us define the standards of diagnostics and treatment of acute postoperative ischaemia. This allowed us to shorten the time between onset of ischaemia and angiography, apply the optimal treatment and finally reduce the ischaemic damage of the myocardium.

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