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ORIGINAL ARTICLE

# Surgical Revascularisation in the Early Phase of ST-Segment Elevation Myocardial Infarction: Haemodynamic Status is More Important Than the Timing of the Operation

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**Background** Surgical revascularisation in patients with acute myocardial infarction with ST-Segment Elevation (STEMI) is usually considered as a second choice when direct angioplasty/stent fails. However, improvements in surgical technique and postoperative care may justify coronary artery bypass grafting (CABG) in STEMI.

**Methods** This was a retrospective analysis of prospectively gathered data of 135 patients with acute STEMI, treated with CABG in our department from February 2008 to December 2012. Patients were divided into two groups – operated up to 6 hours (35 patients) and 6 to 24 hours (100 patients) from onset of symptoms.

**Results** Preoperatively, 18 (13%) patients were in cardiogenic shock, 10 (7.4%) had mechanical ventilation, and 36 (27%) had intra-aortic balloon counterpulsation (IABC). Mean number of distal anastomoses was 3.3 (range, 1 to 5), cardiopulmonary bypass time 122.7 + 52.6 minutes. In hospital (30-day) mortality was 8.1% (11 patients) with no significant difference in both groups ($p = 0.541$); 45 (33%) patients had one MACE, again with no difference in both groups ($p = 0.89$). Risk factor analysis revealed that Killip class at admission, cardiogenic shock, preoperative need for catecholamines, ventilation and low ejection fraction are risk factors for early mortality.

**Conclusions** Acute CABG in patients with STEMI can be performed with good results. Risk factors for early mortality and morbidity are cardiogenic shock, poor haemodynamic status and impaired ejection fraction. Time from infarction to reperfusion did not influence the results.

**Keywords** Acute STEMI • Acute coronary bypass surgery • Surgical treatment of IHD

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# Background

There is a close relationship between the duration of coronary artery occlusion and the extent of myocardial necrosis in patients with acute myocardial infarction. Experimental and clinical studies have shown that the rapid opening of an infarct-related artery in acute myocardial infarction (AMI) results in a larger amount of rescued myocardium, and lower morbidity and mortality [1,2]. Therefore, the main therapeutic strategy, currently, is the fastest possible restoration of blood flow, which is achieved mainly through primary percutaneous coronary intervention (PCI) or by thrombolysis in hospitals where PCI is not available [3]. In the Czech Republic more than 530 PCIs for acute ST-elevation myocardial infarctions (STEMI) per million population are performed each year.

Surgical revascularisation by coronary artery bypass graft (CABG) in acute STEMI is usually considered as a second option when PCI is not technically possible or unsuccessful, or, in the case of the mechanical complications of AMI (ischaemic mitral insufficiency, rupture of the left ventricle free wall, or post-infarction ventricular septal defect). However, improved results of surgical revascularisation due to improvements in surgical technique and postoperative care may justify coronary artery bypass grafting (CABG) in STEMI.

The aim of this study was to evaluate the accumulated experience gained over almost five years.

# Methods

We conducted a retrospective analysis of prospectively obtained data for patients operated in our department, from February 2008 to December 2012, from our database. In this period CABG was performed on 2151 patients, and 135 (6.3%) were operated in acute STEMI within 24 hours of symptom onset. During this period, there was a slight decrease in the frequency of acute CABG from 6.7% in 2008 to 4% in 2012; in absolute numbers, from 39 in 2008 to 20 in 2012.

The inclusion criteria were: Acute STEMI that was considered by the intervention cardiologist as impossible or unsuitable to treat with PCI; STEMI was defined as ST-segment elevation on the electrocardiogram in at least two leads and with positive values of biochemical markers of myocardial necrosis, troponin I and creatine kinase MB-fraction. Coronary angiography was performed on all patients with evidence of acute coronary artery occlusion and findings which did not exclude CABG. Patients with mechanical complications of AMI, such as acute mitral valve insufficiency, rupture of the left ventricle free wall or post-infarction ventricular septal defect were excluded from the analysis.

Endpoints were defined prior to study. The primary endpoint—hospital mortality—was defined as death from any cause during hospitalisation or 30-days after surgery. Secondary endpoints were major adverse cardiac events (MACE) defined as low cardiac output syndrome (LCO), severe neurological dysfunction after surgery, the need for intra-aortic balloon counterpulsation (IABC) longer than 48 hours after surgery or mechanical support of circulation by veno-arterial extracorporeal membrane oxygenation (ECMO), dialysis after surgery and the onset of new ventricular arrhythmias. A separate analysis of the results of patients operated on in the very early phase (first 6 hours) of STEMI and in the interval 6 to 24 hours from the beginning of symptoms was made. The 6-hour interval has been adopted from the National Registry of Cardiovascular Procedure, and it means the time interval from the onset of symptoms to reperfusion of infarct artery or establishment of extracorporeal circulation.

# Characteristics of Patients

The mean age was 66.8 + 9.64 (range 40–84) years; males were predominant (77% vs. 33%). Most patients (111, 82%) had triple vessel disease, almost half (66 patients, 49%) had stenosis of the left main coronary artery trunk. The mean left ventricular ejection fraction was 44.5 + 14.7%. Twenty-two (16.3%) patients had a history of previous PCI of at least one artery. Antiplatelet therapy with acetylsalicylic acid and clopidogrel was given to 38 (28%) patients. Almost all (91%) received heparin before surgery. Intravenous catecholamine support was given to 26 patients (19%), infusion of nitrates was given to 117 (87%). Intra-aortic balloon counterpulsation before surgery was given to 36 (27%) patients. Thirty-five (26%) patients had Class III or IV Killip classification, 18 (13%) were admitted to surgery in cardiogenic shock. The criteria for diagnosing cardiogenic shock were: systolic blood pressure $<$80 mmHg; cardiac index $<$2.0 L/ min/m2; base excess $>$-8 mEq/L; and urine output $<$30 ml in one hour. Preoperative data and risk factors at presentation are summarised in Table 1.

# Surgical Technique

All operations were performed through a median sternotomy, using either a classical technique with extracorporeal circulation and cardiac arrest with cold blood solution, or on a beating heart without extracorporeal circulation (OPCAB) (see Table 2). In four cases (3%) extracorporeal circulation without cardiac arrest (assisted CABG on a beating heart) was used. Most operations were performed using the left internal mammary artery (LIMA) to the left anterior descending artery (LAD) in combination with bypass using autologous saphenous vein to the other branches. If the situation allowed, a complete arterial revascularisation using the LIMA and radial artery or right mammary artery was done. Only venous grafts or resuscitation were used in patients with significant haemodynamic instability. The specific surgical procedure was chosen according to surgeon preference and situation.

**Table 1** Characteristics of Patients with STEMI operated within 24 hours

| Characteristics | All patients n = 135 | Pts operated less than 6 hours after onset of symptoms n = 35 | Pts operated 6-24 hours after onset of symptoms n = 100 | p-value |
|---|---|---|---|---|
| Age (years) | 66.8 + 9.64 | 64.4 + 11.15 | 67.7 + 8.94 | 0.081 |
| sex | | | | |
| male | 104 (77%) | 30 (86%) | 74 (74%) | 0.131 Pearson's |
| female | 31 (33%) | 5 (14%) | 26 (26%) | Chi-squared test |
| Number of coronary arteries with a stenosis >50% | | | | |
| 1 | 4 (2.9%) | 0 | 4 (4%) | 0.631 Fisheŕs |
| 2 | 20 (15%) | 5 (14%) | 15 (15%) | exact test |
| 3 | 111 (82%) | 30 (86%) | 81 (81%) | |
| Left main stenosis | 66 (49%) | 17 (49%) | 49 (49%) | 0.965 |
| Diabetes mellitus | 39 (29%) | 8 (23%) | 31 (31%) | 0.360 |
| Hypertension | 103 (76%) | 24 (69%) | 79 (79%) | 0.212 |
| History of MI | 20 (15%) | 7 (20%) | 13 (13%) | 0.316 |
| Renal dysfunction *(serum creatinine >200 umol/l)* | 1 (0.7%) | 1 (2.9%) | 0 | – |
| Dialysis | 1 (0.7%) | 1 (2.9%) | 0 | |
| COPD | 19 (14%) | 8 (23%) | 11 (11%) | 0.083 |
| Peripheral vascular disease | 22 (16%) | 6 (17%) | 16 (16%) | 0.875 |
| Previous PCI | 22 (16%) | 8 (23%) | 14 (14%) | 0.222 |
| i.v. nitrates | 117 (87%) | 31 (89%) | 86 (86%) | 0.700 |
| Antiplatelet therapy (ASA, clopidogrel) | 38 (28%) | 9 (26%) | 29 (29%) | 0.710 |
| Left ventricular ejection fraction (%) | 44.5 + 14.7 | 44.4 + 16.46 | 44.5 + 14.7 | 0.976 |
| LV EF less than 30% | 22 (16%) | 7 (20%) | 15 (15%) | 0.491 |
| i.v. inotropes | 26 (19%) | 4 (11%) | 22 (22%) | 0.172 |
| Preoperative IABC | 36 (27%) | 8 (23%) | 28 (28%) | 0.554 |
| Preoperative ventilation | 10 (7,4%) | 3 (8,6%) | 7 (7%) | 0.760 |
| Cardiogenic shock | 18 (13%) | 4 (11%) | 14 (14%) | 0.700 |
| Killip class at admission | | | | |
| I | 95 (70%) | 29 (83%) | 66 (66%) | 0.244–Fisheŕs |
| II | 5 (3.7%) | 0 | 5 (5%) | exact test |
| III | 17(13%) | 2 (5.7%) | 15 (15%) | |
| IV | 18 (13%) | 4 (11%) | 14 (14%) | |

Abbreviations: MI = myocardial infarction, COPD = chronic obstructive pulmonary disease, ASA = acetylsalicylic acid, IABC = intraaortic balloon counterpulsation.

# Statistical Analysis

Data are expressed either as mean and standard deviation or as percentages, as appropriate. Statistical analysis was performed using Student's t-test for continuous variables; for categorical variables two sample proportion test, and for contingency tables Pearson's $\chi 2$-test test was used. In the event that the number of observations was smaller than five, Fisher's exact test was used.

Risk factors for the 30-day mortality and MACE, with univariate and multivariate analyses of the collected data were used. Pearson $\chi 2$-test for independence was used in a contingency table, Fisher's factorial test for pole test for tables, t-test consensus mean values in independent selections (or Welch's modification for samples with unequal variances in general), logistic regression model. The list of factors included in the analysis is shown in Table 3.

All calculations were performed using SPSS 11.5 for Windows XP Professional statistical system (SPSS Inc., Chicago, Ill.). Differences with p value less than 0.05 were considered significant.

# Results

From February 2008 until the end of 2012, 1280 patients with acute STEMI were catheterised in our Cardiac Centre,

**Table 2 Intraoperative data**

| | All patients, n = 135 | Pts. operated less than 6 hours after onset of symptoms, n = 35 | Pts. operated 6–24 hours after onset of symptoms, n = 100 | p-value |
|---|---|---|---|---|
| OPCAB | 63 (47%) | 16 (46%) | 47 (47%) | 0.590 |
| Assisted beating heart CABG | 4 (3%) | 0 | 4 (4%) | – |
| CPB time (min.) | 122.7 + 52.6 | 121.9 + 47.04 | 123 + 57.42 | 0.919 |
| X-clamp (min.) | 58.1 + 18.2 | 58.7 + 14.02 | 57.9 + 21.71 | 0.839 |
| Number of anastomosis | 3.3 + 1.23 | 3.25 + 0.8 | 3.32 + 1.23 | 0.754 |
| TAR | 45 (33%) | 13 (37%) | 32 (32%) | 0.579 |
| IABC intraoperatively | 12 (8.9%) | 6 (17%) | 6 (6%) | 0.099 |
| ECMO/LVAD | 2 (1.5%) | 0 | 2 (2%) | – |

Abbreviations: OPCAB = off-pump coronary artery bypass graft, Assisted beating heart CABG = Coronary artery bypass grafting on extracorporeal circulation without cross-clamp, CPB = cardiopulmonary bypass, X-clamp = cross-clamp, TAR = total arterial revascularisation, IABC = Intraaortic balloon counterpulsation, ECMO = Extracorporeal membrane oxygenation.

of which 135 acute CABG procedures were performed, i.e. 10.5% of all STEMI patients. Of these 135 patients, 35 (26.7%) were operated up to 6 hours after onset of symptoms. CABG using LIMA to LAD, combined with vein grafts to other branches, was performed in 71 (53%) patients; 45 patients (33%) had total arterial revascularisation. Venous grafts alone were used in 19 (14%) patients. Off pump coronary bypass (OPCAB) was performed in 63 (47%) patients. The mean number of distal anastomoses was 3.3 ± 1.23 (range 1–5). IABC was inserted intraoperatively in 12 (8.9%) patients, and somewhat more frequently in patients operated up to 6 hours after the onset of symptoms (on the border of statistical significance, $p = 0.099$). Temporary ECMO as a mechanical cardiac support was required in two (1.5%) patients, of whom one died due to multi-organ failure and one was successfully disconnected from mechanical support on the fifth postoperative day. Operative data are listed in Table 2.

**Table 3 Variables used for a univariate and multivariate analysis of risk factors for perioperative mortality and MACE**

| Factor |
|---|
| Gender |
| Age (years) |
| Operated less than 6 hours after onset of symptoms |
| Left main stenosis |
| Diabetes mellitus |
| Hypertension |
| History of myocardial infarct |
| Renal dysfunction *(serum creatinine higher than 200 umol/l)* |
| Dialysis |
| Mean serum creatinine *(umol/l)* |
| COPD |
| Peripheral vascular disease |
| Preoperative PCI |
| Intravenous need for nitrates |
| Preoperative antiplatelets therapy (ASA + clopidogrel) |
| Mean ejection fraction of left ventricle (%) |
| Ejection fraction of left ventricle less than 30% |
| Preoperative ventilation |
| Preoperative need for catecholamines |
| Preoperative IABC |
| Cardiogenic shock |
| Killip Class III + IV |
| OPCAB |

Abbreviations: COPD = chronic obstructive pulmonary disease, PCI = percutaneous coronary intervention, ASA = acetylsalicylic acid, IABC = intraaortic balloon counterpulsation, OPCAB = off-pump coronary artery bypass graft.

The overall 30-day mortality of all patients operated on for acute STEMI was 8.1% (11 patients), with no statistically significant difference in patients operated on up to 6 hours and 6 to 24 hours after the onset of symptoms (5.7% vs 9%, $p = 0.541$). The average logistic EuroScore in this patient group was 21.6%, although the prediction of 30-day mortality according to the EuroScore in patients operated in the acute phase of STEMI is not completely reliable. The highest mortality was in patients who were admitted and operated on in cardiogenic shock, with 44% dying (8 of 18 patients). Compared with patients without shock where the mortality was 2.6% (3 out of 117), the difference was highly significant ($p = 0.0001$). The mortality of patients with Killip Class III and IV status was 31.4% (11 of 35), also a highly significant difference compared to Class 1 and 2 ($p = 0.0001$). The mortality of patients operated on without cardiopulmonary bypass (OPCAB) was 6.3% (4 patients), while patients operated on with extracorporeal circulation was 9.7% (7 patients). This difference was not statistically significant.

One third (33%) of patients suffered one or more postoperative MACE; more than a quarter (27%) had postoperative low cardiac output syndrome (LCO), two (1.5%) had a stroke with permanent deficit, in nine (6.7%) dialysis was necessary

**Table 4** Results

| | All patients, n = 135 | Pts. operated less than 6 hours after onset of symptoms, n = 35 | Pts. operated 6–24 hours after onset of symptoms, n = 100 | p-value |
|---|---|---|---|---|
| In hospital (30-day) mortality | 11 (8.1%) | 2 (5.7%) | 9 (9%) | 0.541 |
| Stroke | 2 (1.6%) | 0 | 2(2%) | – |
| LCOs | 36 (27%) | 9 (26%) | 27 (27%) | 0.882 |
| IABC or ECMO longer than 48 h postoperatively | 9 (6.7%) | 4 (11%) | 5 (5%) | 0.190 |
| Dialysis | 9 (6.7%) | 2 (5.7%) | 7 (7%) | 0.793 |
| Ventricular arrhythmia | 7 (5.2%) | 3 (8.6%) | 4 (4%) | 0.294 |
| MACE total | 45(33%) | 12(34%) | 33 (33%) | 0.890 |
| New Q wave on ECG | 4 (3%) | 0 | 4 (3%) | – |
| Mediastinitis | 2 (1.5%) | 1 (2.9%) | 1 (1%) | 0.434 |
| Reoperation for bleeding | 3 (2.5%) | 0 | 3 (3%) | – |
| Total blood loss (ml) | 922.3 + 405.2 | 894.9 + 391.6 | 931 + 553.67 | 0.723 |
| No of blood units used | 2.34 + 4.6 | 1.91 + 4.5 | 2.49 + 4.84 | 0.536 |
| Length of hospitalisation after surgery (days) | 13.9 + 8.3 | 12.1 + 6.89 | 14.5 + 15.4 | 0.375 |

Abbreviations: LCOs = low cardiac output syndrome, IABC = intraaortic balloon counterpulsation, ECMO = extracorporeal membrane oxygenation, MACE = - major adverse cardiac event.

after surgery. Nine (6.7%) patients had IABC more than 48 hours after surgery or ECMO support. Seven patients (5.2%) had new onset ventricular arrhythmia. There was no significant difference in MACE or other complications observed between the early group and patients operated 6 to 24 hours after the STEMI. Two patients (1.5%) had deep wound infection, which required surgical revision of the wound and subsequent sternoplasty with pectoralis muscles. Mean hospital stay after surgery was 13.9 + 8.3 days; compared with elective CABG for the same period where the length of hospitalisation after surgery was 9.92 + 7.45 days (p = 0.00012). Operative results are summarised in Table 4.

# Risk Factor Analysis

In the univariate analysis, we found that the risk of mortality is increased by factors associated with haemodynamic instability. The most important risk factor is cardiogenic shock, which increases the chance of death 28.7 times (p-value = $5.8 \times 10^{-6}$). Killip class at admission, with each point in that variable increasing the chances of death 6.9 times (p-value = 0.00038), preoperative need for catecholamines, which increases the chance of death 8.6 times (p-value = 0.0074) and mechanical ventilation increases the chance of death 13 times (p-value = 0.00076). The other risk factor is left ventricular ejection fraction (in %), with each increase in percentage point decreasing the chances of death 1.103 times (10% increase in EF decreases the chance of death 2.65 times, with p-value = 0.0024).

In the univariate analysis for MACE only two factors were significant—the degree of Killip classification, with every point in that variable increasing the chance of MACE 1.56 times (p-value = 0.0053) and left ventricular ejection fraction, with each percentage point increase in EF decreasing the chance of MACE 1.032 times (10% increase decreases the chance 1.37 times, p-value = 0.010).

Multivariate regression analysis confirmed the very low number of independent risk factors with demonstrable impact on mortality or MACE. Only the degree of Killip classification increases mortality and MACE at 10% significance level.

The results of the analysis are summarised in Table 5.

**Table 5** Univariate and multivariate analysis of risk factors for 30-day mortality

| Factor | HR (95% CI) | p-value |
|---|---|---|
| Ejection fraction | 1.103 | 0.0024 |
| Preoperative ventilation | 13 | 0.00076 |
| Preoperative need for catecholamines | 8.6 | 0.0074 |
| Cardiogenic shock | 28.7 | $5.8 \times 10^{-6}$ |
| Killip class at admission | 6.9 | 0.00038 |
| **Univariate Analysis of Risk Factors for MACE** | | |
| Ejection fraction | 1.032 | 0.010 |
| Killip class at admission | 1.56 | 0.0053 |
| **Multivariate Analysis for MACE** | | |
| Killip class at admission | 1.034 | 0.010 |

Abbreviations: CI = confidence interval, HR = hazard ratio.

# Discussion

Acute myocardial infarction remains a major cause of morbidity and mortality in developed countries. It has been shown that the most effective treatment of acute MI is an early revascularisation [1,2]. Currently, the most common treatment for acute STEMI is either PCI or, in its absence, thrombolytic therapy, in accordance with the recommendations of guidelines of the American College of Cardiology (ACC), American Heart Association (AHA) and European Society of Cardiology (ESC) [3–5]. Acute CABG is usually considered as second-choice therapy when PCI either fails or is impossible to perform. In patients treated for acute STEMI in our centre acute CABG was indicated in 10.5% of all cases.

Percutaneous coronary intervention has undergone great progress, especially in new technologies and stents in recent decades. Similar advances in the development of surgical techniques, anaesthesia and postoperative care have led to improved results, and made it possible to operate on higher risk patients. The results from many centres suggest that acute CABG could not only be a rescue therapy when PCI is not possible, but CABG offers a reasonable alternative to PCI [6–8].

Coronary artery bypass grafting in patients with STEMI may potentially have some advantages. First, it provides complete revascularisation in all patients, and compared with PCI it offers a wider range of options in technical design, depending on the status and haemodynamic stability of the patient. In addition to conventional CABG with extracorporeal circulation and cardioplegic arrest, the use of controlled reperfusion of infarction, or operation using cardiopulmonary bypass on a beating heart (known as assisted CABG), operation without cardiopulmonary bypass (OPCAB), or combining PCI and CABG as hybrid revascularisation are possible. In the case of haemodynamic and organ failure, temporary mechanical cardiac support with ECMO or left ventricular assist device (LVAD) can be used. Currently, there are no clear data that would support the use of some of these techniques, although recent papers document the benefits of OPCAB use in high-risk patients with STEMI [8,9]. The decision is fully reliant on the experience of the surgeon and the strategy of each centre. In our cohort of patients, half of the operations were OPCAB (47%), and the proportion of OPCAB operations during the follow-up period also increased from 28% in 2006 to 71% in 2010. It is our policy to perform total arterial revascularisation (TAR) whenever possible. Also in this high-risk group of patients, TAR was able to be achieved in one third (33%).

Patients undergoing acute CABG for STEMI represent a unique subset of the high-risk population, which remains a challenge for cardiac surgeons [10]. This corresponds to a higher 30-day (or in-hospital) mortality of 8.1% in this series, which can hardly be compared with normal elective CABG, where the mortality rate over the same period was 1.23%. The average logistic EuroScore in this group was 21.6%.

The strongest predictors of 30-day mortality are haemodynamic instability and/or cardiogenic shock before surgery [4,6,7]. In patients with acute MI undergoing PCI, the haemodynamic status on admission, as assessed by the Killip classification, is a simple and reliable independent predictor of hospital mortality and 6-month mortality [11]. Similarly, in the patients undergoing acute CABG for STEMI, Killip classification on admission proved a strong predictor of early mortality. The overall mortality in our group is fully comparable with the data of published studies. Hagl et al. reported a group of patients operated on for STEMI, within 48 hours of symptom onset, with 33% of patients in cardiogenic shock and cardiopulmonary resuscitation in 16%, and the 30-day mortality was 20% [6]. Maganti et al. identified an emergent CABG mortality of 8.1%, and 25% of patients suffered low cardiac output syndrome after surgery [10].

One third (33%) of our patients had one episode of MACE. There was also a longer time for hospitalisation of patients after surgery than in elective patients.

Univariate analysis of risk factors for early mortality showed that the strongest predictor was cardiogenic shock before surgery, followed by factors related to haemodynamic instability such as the degree of Killip class, and the need for catecholamines or ventilation before surgery. Mortality was adversely affected also by low left ventricular ejection fraction. In the case of MACE, only the degree of Killip classification was significant, with LVEF reaching the upper limit of statistical significance ($p = 0.01$). A surprising finding was that there was no statistically significant difference in early mortality, MACE, or postoperative complications between patients operated within 6 hours and at 6 to 24 hours after onset of symptoms. Although the relationship between mortality and time of reperfusion has been demonstrated in patients with acute STEMI treated with thrombolysis [12], or PCI [13,14], for patients with early surgical revascularisation the early mortality seems to depend much more on the haemodynamic status and left ventricular function than the early timing of reperfusion if the patient is operated within 24 hours after MI. Haemodynamic status is primarily influenced by the extent of myocardial necrosis, and the degree of left ventricular impairment. Therefore, primary treatment efforts are directed to preventing or at least reducing myocardial ischaemia and myocardial blood flow restoration. This goal is best met by early and complete revascularisation, if possible. Another therapeutic strategy is to reduce the work demands of the left ventricle. This goal is met by mechanical cardiac support by IABC, ECMO or LVAD. In this way time for revascularisation and prevention of organ dysfunction can be obtained. We believe that more frequent use of LVAD in unstable patients will lead to further improvement in the results of CABG in STEMI.

# Limitations

This is a non-randomised, observational study with a limited number of patients and is subject to all the limitations associated with this type of research. This is a retrospective analysis of prospectively collected data. The nature of STEMI, unfortunately, excludes prospective randomised study in surgical patients. For these reasons the study also does not have ideal control group patients to allow comparison.

# Conclusions

Acute CABG in STEMI can be performed with good results. Surgical mortality of 8.1% is higher than for elective CABG, but reflects a subset of high-risk patients. The most significant risk factors for 30-day mortality and MACE are associated with the haemodynamic instability, i.e. cardiogenic shock, degree of Killip class at admission, and low left ventricular ejection fraction. We failed to demonstrate any difference in early mortality or MACE in patients operated on up to 6 hours, and patients operated 6 to 24 hours after the onset of symptoms.

# Conflict of Interest

The authors report no financial relationships or conflicts of interest regarding the content herein.

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