Coronary artery bypass graft in patient with left ventricle dysfunction

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Abstract

Background and aims: Despite advances in perioperative management in CABG surgery, surgical risk persists in patients with LV dysfunction and may result in increased morbidity and mortality. We aim to study the postoperative complications and the early mortality.

Methods: We conducted a retrospective and observational study in the military hospital of Tunis from January 2012 to December 2021. We included patients candidates to CABG with a preoperative LVEF ≤ 40%. Patients with concomitant cardiac or valvular surgeries and those treating a mechanical complication of myocardial infarction (MI) were not included. Beating-heart (HB) surgery and incomplete or lost-to-follow-up records were excluded. Early mortality was defined as any death occurring within 30 days.

Results: During the period of the study, 73 patients were included. The mean age was 60,5 ± 7,5 years. The main comorbidities were diabetes (55%), chronic kidney disease (47%) and hypertension (46%). The 30-day mortality risk estimated by STS SCORE was 1,3 ± 1,07%. The mean duration of postoperative mechanical ventilation was 6 ± 3 hours. Intra-aortic balloon counterpulsation (IABP) was used postoperatively in 15 patients (20%). The early mortality rate was 22%. The main complications were postoperative Low Cardiac Output Syndrome (37%), infectious complications (28%), acute renal failure (19%) and acute coronary syndrome (17%). Prolonged mechanical ventilation (>10 hours) and postoperative LVEF ≤33 % were the reliable predictive factors of early mortality.

Conclusion: CABG for patients with HFrEF is associated with a significant operative risk. Several predictor factors can be addressed before surgery.

Keywords

Coronary bypass ; left ventricle dysfunction; complications; mortality

Résumé

Mots-clés

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INTRODUCTION

The decision of coronary artery bypass grafting (CABG) is based on certain criteria, such as clinical presentation, systolic ventricular function, and coronary anatomy.

In recent years, there has been an increase in the number of patients with reduced left ventricular ejection fraction (LVEF) who are candidates for CABG. Indeed, the studies showed a superiority of CABG compared to medical treatment alone, improving symptoms and increasing survival [1,2]. Advances in perioperative management, surgical techniques, and myocardial protection methods have encouraged practitioners to consider this option more frequently [3].

However, despite these improvements, surgical risk persists and may result in increased morbidity and mortality.

In this context, studying complications and identifying their predictors is crucial to determining who will benefit most from surgical revascularisation procedures.

The objective of this study was to investigate the complications and early mortality of surgical myocardial revascularisation under extracorporeal circulation (ECC) in patients with reduced LVEF (preoperative LVEF ≤ 40%).

METHODS

We conducted a retrospective, observational, single-centre study, carried out in collaboration between the cardiology department and the thoracic surgery department of the military hospital of Tunis during a period of ten years from January 2012 to December 2021. We included patients candidates to coronary bypass and having a preoperative left ventricular dysfunction with an LVEF ≤ 40%. Patients with LVEF > 40%, concomitant cardiac or valvular surgeries and those treating a mechanical complication of myocardial infarction (MI) were not included. Beating-heart (HB) surgery and incomplete or lost-to-follow-up records were excluded.

For each patient, we collected demographics, pre-, per, and post-operative characteristics, and early post-operative complications (≤ 30 days).

Some complications need to be defined. Type 5 or iatrogenic MI during coronary artery bypass graft surgery was defined as troponin elevation more than 10 times the normal value or more than 20% for patients with initial high values associated with at least one of the following: symptoms of acute myocardial ischaemia, dynamic ECG changes or pathologic Q waves, or new loss of viable myocardium or new regional wall motion abnormality in a pattern consistent with an ischemic etiology [4].

Postoperative low cardiac output syndrome (LCOS) was defined as a decrease in cardiac output (below 2.2 L/min/m^2) with signs of hypoperfusion (excluding hypovolemia), the need for two inotropic drugs postoperatively, or the need for mechanical circulatory support to exit ECC or postoperatively [5].

Early mortality was defined as any death occurring within 30 days of surgery or during hospitalization.

Through a statistical analysis, the predictors of early mortality were investigated.

ANALYTICAL STUDY

It was conducted by IBM® SPSS-statistic® version 28 software. For the qualitative variables, frequencies were calculated, while for the quantitative variables, the means, medians and standard deviations were determined. The results following a normal distribution were expressed as mean ± SD, and those not complying with this distribution were represented by the median and interquartile range. The normal distribution was confirmed by the Shapiro-Wilk and K-S tests.

The search for risk factors was carried out by calculating the Odds Ratio (OR) and its confidence interval. For the calculation of the ORs of the quantitative variables, they were transformed into qualitative variables with two modalities. The distribution threshold of the quantitative variable was determined using the ROC (Receiver Operating Curves). After verifying that the area under the curve was significantly greater than 0.50, the threshold was chosen based on the value of the variable that offered the best sensitivity and specificity, in accordance with Youden's point.

Multivariate analysis was only implemented when the number of individuals per group exceeded 30. It was conducted using logistic regression, using a step-by-step explanation.

RESULTS

During the study period, 73 patients were enrolled. Patient selection is shown in Figure 1.

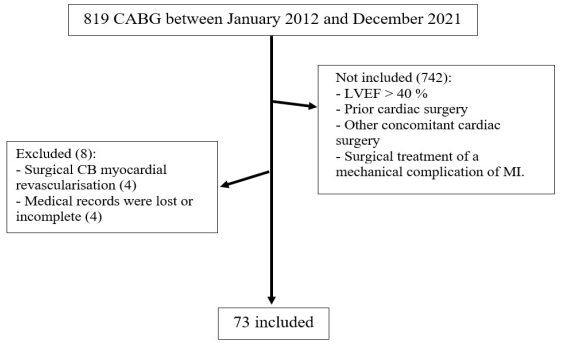

Figure 1. Flow chart of patients selection

DESCRIPTIVE STUDY

The basic characteristics of the patients are presented in the table below:

Table 1. Baseline characteristics

Male sex (n,%)	64 (88)
Age (years)	60,5 ± 7,5
Hypertension (n,%)	34 (46)
Diabetes (n,%)	40 (55)
CKD (n,%)	35 (47)
Obesity (BMI ≥30 kg/m²) (n,%)	10 (14)
Stroke (n,%)	5(7)
COPD (n,%)	11 (15)
Initial presentation NSTEMI (n,%)	37 (50)
Initial presentation STEMI (n,%)	21 (29)
Atrial fibrillation (n,%)	4 (5)
Hemoglobin level(g/dl)	13 ± 1.8
HbA1C in diabetic patients (%)	8,9 ± 2,2
eGFR (ml/min)	82,8 ± 31,6
LVEF (%)	37 ± 3
EUROSCORE II (%)	2,81 ± 2,17
30-day mortality risk estimated by STS SCORE (%)	1,3 ± 1,07
Time to surgery after coronary angiography (days)	39 ± 8
Complete revascularisation (n,%)	39 (53)
ECC duration (minutes)	124 ± 46

BMI: body mass index; COPD: chronic obstructive pulmonary disease; CKD: chronic kidney disease; ECC: extracorporeal circulation; eGFR: estimated glomerular filtration rate; HbA1c: glycated hemoglobin; LAM: left main artery; LVEF: left ventricle ejection fraction; NSTEMI: Non-ST elevation myocardial infarction; NYHA: New York Heart Association; STEMI: ST elevation myocardial infarction; STS: society of thoracic surgeons

POSTOPERATIVE EVOLUTION

The post-operative hospitalization time in the resuscitation department was 3 hours (IQR 2-4). The mean duration of mechanical ventilation was 6 ± 3 hours (2 to 240 hours). In 29 patients (41%), withdrawal from ECC was difficult, requiring administration of high doses of catecholamines for more than 24 hours. Intra-aortic balloon counterpulsation (IABP) was used postoperatively in 15 patients (20%).

The mean post-operative hemoglobin level was 9.5±1.4 g/dl and ranged from 5.7 to 13.4 g/dl. The mean of post-operative deglobulisation was 3.6±1.6 g/dl. The median of transfusion was 2 packed Red Blood Cells per patient. Postoperative LVEF was found in 65 cases (89% of cases). The mean was 39.7 ± 7.6%. One patient died during the operation, and 15 patients (21%) died within the first month postoperatively, with an early mortality rate of 22%.

Early postoperative complications

The main cardiovascular complications are presented in the figure below:

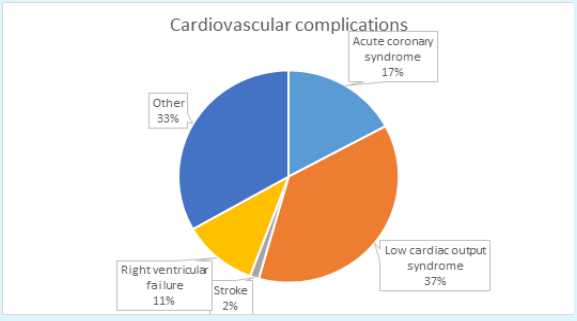

Figure 2. Main early cardiovascular complications

The other non-cardiovascular events are summarized in the table below:

Table 2. Non-cardiovascular complications

Complications	n (%)
Intrathoracic bleeding	1(1)
Surgical revision	8(10)
Pericardial effusion	13(18)
Cardiac tamponade	2(3)
Pulmonary embolism	1 (1)
Atrial fibrillation	3 (4)
Ventricular tachycardia	1 (1)
Complete AV block requiring permanent pacemaker	2 (3)
Infectious complications	25 (28)
Acute renal failure	14(19)

AV : atrio-ventricular

ANALYTICAL STUDY

The most important predictors of early mortality are presented below:

Table 3. Predictor factors of early mortalitys

Risk factor	OR (IC95%)	p-value
Postoperative IABP use	6,25 (1,7 ; 22,6)	0,007
LCOS	15,5 (1,9 ;126,5)	0,002
Postoperative acute coronary syndrome	9,4 (2,5 ; 35,2)	$<10^{-3}$
Postoperative acute renal failure	6,3 (1,7 ; 22,6)	0,007
Postoperative infection	12,3 (3,3 ; 45,3)	<10-3
EUROSCORE II ≥ 2,65	5,3 (1,56 ;18,8)	0,009
30-day mortality risk: STS SCORE ≥ 1,24	5,2 (1,4 ;19,0)	0,01
Mechanical ventilation for more than 10 hours	41,8(4,8 ;362,0)	$<10^{-3}$
Postoperative LVEF ≤33 %	14,25 (5,5; 36,6)	$<10^{-3}$
Postoperative Hb level ≤9,1 g/dl	7,0 (1,32 ;37,1)	0,023

Hb: hemoglobin; IABP: intra-aortic balloon conterpulsation; LCOS: low cardiac output syndrome; LVEF: left ventricle ejection fraction; STS: Society of thoracic surgery

The analysis of the ROC curves (Figure 2) revealed two reliable predictive factors of early mortality: the duration of mechanical ventilation (AUC= 0.82) and the post-operative LVEF (AUC = 0.98)

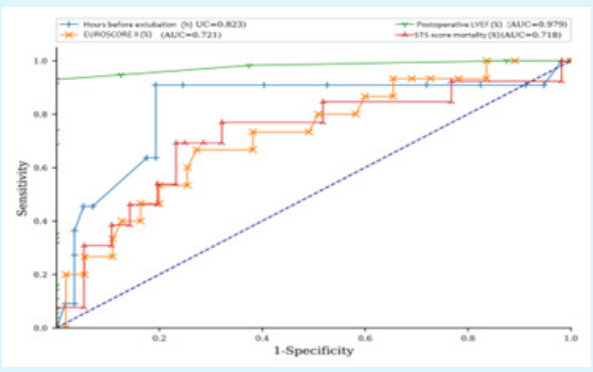

Figure 1. Analysis of ROC Curves of quantitative risk factors for early postoperative Mortality

DISCUSSION

In our study, major postoperative events and predictor factors of early mortality were reported.

LOCS is the most common and severe complication following cardiac surgery. It is associated with a significant increase in morbidity and mortality in the short and medium term. Common LOCS-related complications include acute renal failure, neurologic problems, pulmonary complications, and atrial fibrillation [6].

Risk factors associated with LOCS include advanced age (more than 65 years), female gender, diabetes, reduced LVEF, previous surgeries, recent myocardial infarction, incomplete revascularisation and ineffective intraoperative myocardial protection [7].

Treatment of LOCS is complex, and it consists of preventing further organ dysfunction and failure by providing adequate hemodynamic support.

Sixteen percent of patients experienced post-operative coronary events, including 7.2% NSTEMI and 2.7% STEMI.

By comparing these results with those of the literature, it is found that the post-operative STEMI rate varied between 0.6% in the STS register [8] and 3.4% in the Shennib et al. series. [9]. Our prevalences of NSTEMI and STEMI were higher than those of the Moroccan series of Tribak et al. [10], which reported rates of 5.8% and 1.7%, respectively. However, nationally, our results were consistent with those of Mhiri et al. [11] (prevalences of 7.1% and 2.4% respectively).

Postoperative myocardial infarction may be explained by factors related to the graft (hematoma, dissection, torsion, hyperextension, spasm …), the surgical technique (anastomotic defects) or the native circulation (incomplete revascularisation, coronary embolization…) [12].

The prevalence of postoperative stroke in our study is relatively low compared to results from other previous research that showed postoperative stroke rates ranging from 1% to 4.5% [13].

Bleeding and blood transfusions are common surgical complications in patients undergoing CABG [14].

In our study, the mean post-operative deglobulisation was 3.6±1.6 g/dl. This result is consistent with what has been reported by Ascione R. and al.[15].

In this reduced LVEF cohort with CABG, deglobulisation with a post-operative Hb ≤ 9 g/dl was a predictor factor of early mortality.

The need for further intervention to control bleeding occurs in two to six percent of CABG cases and carries a 4.5-fold risk of mortality [16-19].

Postoperative AF occurred in our study. This complication, although common with rates up to 30% in the literature, had a lower prevalence of 4.1% in this study [20,21].

Generally transient, this AF resolves in most patients within 2 to 3 days of treatment. However, patients with preoperative AF showed little chance of spontaneous recovery to sinus rhythm. The causes of this complication include pericardial inflammation, excessive catecholamine production and various postoperative neuro-hormonal

imbalances [21-23]. This complication increases the stroke risk, hospitalization time, care costs, and mortality by two to three times [19-24].

Concerning other arrhythmias, 1.3% experienced ventricular tachycardia. This rate was comparable to literature. The study of Sadr-Ameli [25] (856 patients undergoing CABG) showed an incidence of 5.4% monomorphic sustained ventricular tachycardia, 0.8% polymorphic ventricular tachycardia and 2.7% ventricular fibrillation.

The infectious complication was identified as an independent risk factor for increased short-term morbidity and mortality. Early postoperative acute mediastinitis is a known complication following cardiac surgery with median vertical sternotomy, with an incidence ranging from 0.14 to 2.9% in studies, and up to 10% in extreme cases [26,27]. This complication tends to complicate coronary surgeries preferentially compared to valvular or combined procedures [27].

Nineteen percent developed an early acute renal failure. In the literature, renal failure, as part of the Euroscore II parameters, has been clearly established as a predictor of mortality by different teams, making it a major complication in patients undergoing cardiac surgery [28]. Its incidence can increase to 39% in patients undergoing cardiac surgery [29].

Risk factors associated with acute renal failure in the context of cardiac surgery can be classified based on patient characteristics (age and pre-existing CKD [30-36]), operating context (urgency of surgery [32, 37-39], hemodynamic instability and use of mechanical circulatory support prior to surgery [39]), and procedural factors (prolonged duration of ECC [40,41]).

Prolonged mechanical ventilation beyond 72 hours was associated with increased mortality in patients with HFrEF or respiratory failure [42]. It exposes patients to potential complications, such as ventilator-associated pneumonia, atelectasis, abdominal distention, stress ulcer, and ventilator myopathy [43].

CONCLUSION AND LIMITATIONS

CABG for patients with HFrEF is associated with a significant operative risk. This was reflected in the morbidity and mortality observed in our study.

Several predictor factors can be addressed before surgery outside of urgent situations. This involves careful patient selection and a pre-operative preparation phase, which is very important especially in relation to comorbidities such as diabetes and CKD.

Although the operative data are not clear from our results, the time for aortic clamping and myocardial ischaemia should be minimised, particularly to reduce the incidence of LOCS. Myocardial protection should be rigourous, regardless of strategy. Revascularisation with a beating heart can be a radical solution, avoiding aortic clamping and reducing deleterious effects.

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