Impact of intraoperative transesophageal echocardiography in mortality in coronary artery bypass grafting

Impacto do ecocardiograma transesofágico intraoperatório na mortalidade em cirurgia de revascularização do miocárdio com circulação extracorpórea

Marcello Fonseca Salgado Filho[1]; Nubia Verçosa[2]; Ismar Lima Cavalcanti[3]; Leonardo Augusto Miana[4]; Cleber Macharet de Souza[5]; Eduardo Borato[6]; Izabela Palitot[7]

A B S T R A C T

Objective: To evaluate the rates of mortality and morbidity in patients undergoing coronary artery bypass grafting (CABG) with cardiopulmonary bypass (CPB) using routine intraoperative transesophageal echocardiography (ITEE). **Methods**: We conducted a retrospective, observational review of medical records of 360 patients from April 2010 to April 2012. We analyzed: age, weight, height, gender, EuroSCORE, diabetes mellitus, ejection fraction and number of diseased vessels. Outcomes were compiled in intraoperative and postoperative (myocardial infarction, stroke, renal failure, hemodialysis, atrial fibrillation, length of stay in the intensive care unit). **Results**: 53 patients were included, with 27 receiving monitoring; we excluded 307 individuals, as they were not operated by the same surgical team. The two groups were homogeneous for age, weight and gender. However, the ejection fraction was lower in the group submitted to ITEE (ITEE group 56.3% versus Non-ITEE group 65.9 ± 11%, p = 0.01). In patients not subjected to ITEE, mortality was higher (ITEE group 0% versus Non-ITEE group 7.6%, p = 0.01). There was no significant difference between groups as for the incidence of stroke, myocardial infarction, atrial fibrillation and acute kidney injury. **Conclusion**: The use of intraoperative transesophageal echocardiography in patients undergoing coronary artery bypass grafting with cardiopulmonary bypass decreased perioperative mortality, warranted the use of inotropic drugs and vasodilators and contributed to a better patient outcome.

Key words: transesophageal echocardiography. Cardiac surgical procedures. Extracorporeal circulation. Cardiotonic. Vasodilators.

INTRODUCTION

The first coronary artery bypass graft (CABG) was performed in 1967 by Dr. William Longmire, who made the anastomosis of the left saphenous vein to right coronary artery[1]. With technological innovation and technical improvement, cardiac surgery has spread worldwide. Nowadays CABG is the most common cardiac surgical procedure [2].

Among the technical improvements, we can emphasize the best strategies of myocardial protection, best management practices of the internal mammary artery, advances in monitoring, especially intraoperative transesophageal echocardiography (ITEE) and the development of ventricular assisting devices [3-5] and discovery of new drugs. We observe, therefore, a lower incidence of complications and mortality in patients undergoing CABG with cardiopulmonary bypass (CPB) [3-5].

The rate of in-hospital mortality worldwide ranges from 3 to 10% 3.2% [6]. Among the risk factors that most contribute to perioperative mortality stand out insulin dependent diabetes mellitus, chronic renal failure requiring hemodialysis, emergency operations, cardiogenic shock and reoperations [6].

One of the most feared complications of perioperative myocardial revascularization is the perioperative infarction. Within the current classification of acute myocardial infarction, intraoperative infarction is classified as type I (platelet rupture) and type II (imbalance between oxygen supply and demand) [7].

Post-Graduation Program in Surgical Sciences, Department of Surgery, Faculty of Medicine, Federal University of Rio de Janeiro. Work performed at the Santa Casa de Misericórdia (Holy Home of Mercy) of Juiz de Fora – SCMJF, Juiz de Fora, Minas Gerais State – MG, Brazil.

1. Coordinator, Course of Intraoperative Echocardiography, Brazilian Society of Anesthesiology; 2. Assistant Professor, Department of Surgery, Faculty of Medicine, Federal University of Rio de Janeiro; 3. Associate Professor, Fluminense Federal University; 4. Associate Professor, Federal University of Juiz de For a; 5. Member, Committee Cardiovascular of Anesthesia, Brazilian Society of Anesthesiology; 6. Cardiologist, Santa Casa de Misericórdia de Juiz de Fora; 7. Nurse, Mount Sinai Maternity Hospital, Juiz de Fora.

During CABG, the presence of a new segmental ventricular dysfunction diagnosed by ITEE has 100% positive predictive value, besides being able to locate the affected coronary artery [7]. The ITEE also directs fluid replacement and inotropic agents and vasodilators during surgery, resulting in lower hospital mortality [6,7].

However, O'Brien *et al.* [8] showed that patients undergoing cardiac surgery with high EuroSCORE (European assessment of cardiac risk surgery), low functional class according to the New York Heart Association (NYHA) and who were routinely submitted to ITEE, to the hemoconcentrator (used for ultrafiltration of blood and removal of excess fluid) and to more transfusions, had a higher mortality rate.

The aim of this study was to evaluate the rates of morbidity and mortality in patients undergoing coronary artery bypass grafting (CABG) with cardiopulmonary bypass (CPB) using routine ITEE, and to compare them with those who did not receive this type of monitoring.

METHODS

After approval by the Ethics in Research Committee of the Holy Home of Mercy of Juiz de Fora – SCMJF (Report No. 39525/2012), we performed a retrospective analysis of the medical records of 360 patients undergoing CABG with CPB in the period from April 2010 to April, 2012.

We included in the study patients aged above 40 years, of both genders, with obstructive coronary disease, using beta-blockers with sinus rhythm electrocardiogram, ejection fraction greater than 35% and hematocrit greater than 30g/dl, submitted to CABG with CPB by the same team.

Exclusion criteria were: CABG operations without CPB, emergency surgery (less than six hours of cardiac catheterization), combined operations (valve operations, left ventricular aneurysmectomy, operations in the aorta, carotid endarterectomy), hemodynamic instability (use of inotropic agents after induction of anesthesia until the start of CPB), chest pain and / or electrocardiographic changes before induction of anesthesia, patients with significant valvar lesion (moderate to severe insufficiency or stenosis), use of intra-aortic balloon (IAB) and plasma creatinine greater than 2mg/dl in the preoperative period.

All operations were performed by the same team and ITEE evaluation was conducted by an experienced anesthesiologist. Echocardiographic examinations were performed by means of the apparatus Vivid I® (GE Medical System, Israel) according to the criteria of the American Society of Cardiovascular Anesthesiology [9,10].

We annotated EuroSCORE, the ASA, ejection fraction, presence of diabetes mellitus, number of affected coronary arteries, presence of perioperative myocardial infarction, heart failure, stroke, renal dysfunction, acute perioperative atrial fibrillation, time (minutes) of CPB, number of coronary anastomoses and time (days) of hospitalization in the intensive care unit (ICU).

The groups were classified according to the use or not of ITEE. All patients in ITEE group underwent CABG with CPB and were monitored with transesophageal echocardiography from induction of anesthesia until the end of the anesthetic procedure.

Patients in the Non-ITEE group underwent the same surgical procedures but did not receive this monitoring.

The immediate postoperative period was conducted in the ICU, where all patients in both groups went through the same hemodynamic evaluations and clinical treatments.

For the analysis of the evolution we adopted the outcomes observed in the intra -and postoperative periods until discharge: 1) in-hospital mortality; 2) perioperative myocardial infarction (diagnosed when there appeared a new Q wave on ECG or ST segment elevation – Minnesota Code) [11,12]; 3) when cardiac enzymes (creatine kinase MB fraction – CK-MB) are five times above baseline [12]; 4) perioperative heart failure, defined as need for use of ventricular support (extracorporeal oxygenation membrane) [11]; 5) use of intra-aortic balloon (IAB); 6) use of inotropic or vasopressor agents for over 48 hours; 7) perioperative strokes diagnosed by clinical evaluation and confirmed by imaging (computed tomography – CT) or magnetic resonance imaging (MRI) of the head 11; 8) perioperative renal dysfunction – when plasma creatinine was greater than or equal to 2mg / dl, accompanied by an increase of 0.7 mg / dL from baseline 11; renal failure defined as renal dysfunction requiring hemodialysis 11; 9) total CPB time; 10) number of coronary anastomoses; 11) incidence of acute atrial fibrillation; and 12) length of ICU stay.

The ITEE analysis was performed in the pre-CPB (after induction of anesthesia and before surgical incision) and in the post-CPB, during weaning from cardiopulmonary bypass, ten minutes after the end of infusion of protamine and after sternal closure.

The echocardiographic study evaluated the following parameters: 1) function of the left (LV) and right (RV) ventricles; 2) analysis of the mitral, tricuspid, aortic and pulmonary valves; 3) cardiac LV output; 4) Tei index (evaluation of LV ventricular function); 5) LV diastolic pattern [10-13].

Parametric data were analyzed by Student's t test, nonparametric data by Mann-Whitney test, and categorical data, by the chi- square or Fisher tests. The software used was GraphPad Prism version 5.00 for Mac OS X, GraphPad Software, San Diego California USA. Statistical significance was set at $p < 0.05$. Results are presented as mean ± standard deviation

The calculation for 25 patients per group, in a total of 50 patients, correspond to a confidence value equal to 6 for 95% probability.

RESULTS

Of the 360 clinical charts of the patients, 289 were excluded because they had not undergone CABG by the same team (anesthesiologist / surgeon / perfusionist). Of the remaining 71 patients, three had an ejection fraction less than 35%, ten underwent combined operations and five had serum creatinine greater than 2mg/dl. In total, 53 patients were subjected to statistical analysis: 27 (59.9%) of them belonged to the ITEE group and 26 (49.1%) to the non-ITEE group(Figure 1).

Table 1 shows demographics and risk factors of both groups. There was no statistical difference between the groups, except for the preoperative ejection fraction, which was lower in the ITEE group (p = 0.01).

Figure 2 shows the result of mortality and survival during the hospital stay between the two groups. There were no deaths in the ITEE group (p = 0.001). The Non-ITEE group displayed 7.6% mortality.

There was no difference between the outcomes studied with both groups in the intra and postoperative periods until discharge. The number of coronary anastomoses, CPB time and number of days in the ICU were similar in both groups (Table 2).

DISCUSSION

The results of this retrospective observational study demonstrated that patients undergoing CABG with CPB who did not use the ITEE as routine monitoring had a higher mortality than the group of patients who used ITEE routinely, 7.6% and 0%, respectively.

In Brazil, there is no study that has evaluated the mortality and morbidity of CABG surgery with CPB by comparing the use or not of ITEE.

Of the patients who died, one had an ischemic stroke and developed pneumonia and sepsis, and the other had cardiogenic shock.

Multicenter studies analyzing mortality and morbidity in patients monitored by pulmonary artery catheter (gold standard for evaluation of ventricular function in patients undergoing CABG) showed that patients who used this type of monitoring showed a higher incidence of organ dysfunction and mortality during hospitalization [3,11,14].

The ITEE is used in the United States for heart surgery since the 80's [3,15]. In a 1996 prospective, randomized study Bergquist *et al.* [16] demonstrated lower mortality and morbidity of the ITEE group when compared with the group not routinely submitted to ITEE. Another study, with 850

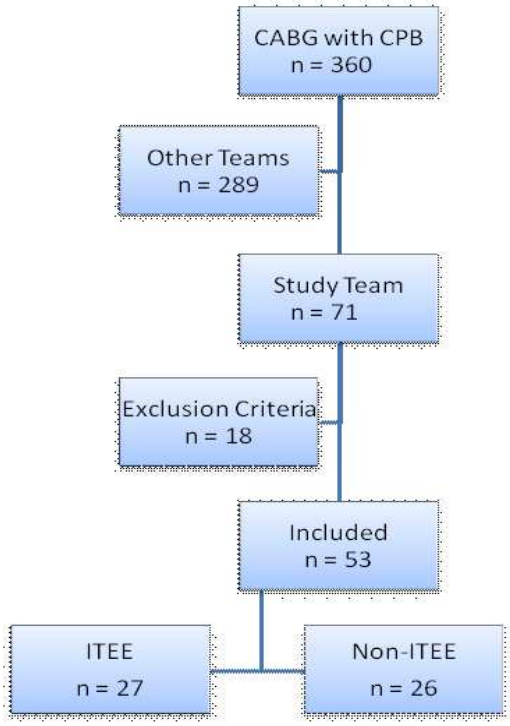

Figure 1 - *Study design showing moderate the total number of patients submitted to CABG with CPB, excluded patients, and patients included in the survey and analyzed the Intraoperative Transesophageal Echocardiography (ITEE) Group and Non-ITEE group.*

Table 1 - Demographic characteristics and risk factors of the patients during the pre-anesthetic assessment.

Data	Without ITEE	With ITEE	*p Value*
Total Patients, n (%)	26 (49.1%)	27 (50.9%)	0.88
Age (years)	63.1 ± 11	61.2 ± 8.8	0.73
Weight (Kg)	72.8 ± 9.8	68.6 ± 11	0.05
Height (cm)	166.5 ± 6.5	163 ± 10.5	0.15
Gender male, n (%)	19 (73%)	16 (59%)	0.05
EuroSCORE (points)	6.9 ± 6.1	7.0 ± 6.6	0.89
Diabetes Mellitus, n (%)	6 (30%)	7 (35%)	0.5
Ejection Fraction (%)	65.9 ± 11	56.3 ± 14	* 0.01
Coronary Arteries Affected, n	3.3 ± 0.6	3.4 ± 0.9	0.85

**-statistical significance, p < 0.05 between the means of the two groups by the Student's t-test.*

Table 2 - CPB time, number of coronary anastomoses and outcomes of patients in the perioperative period and postoperative one until hospital discharge.

Data	Without ITEE	With ITEE	*p Value*
CPB (min)	91 ± 25	81.2 ± 23.6	0.33
Coronary anastomoses, n	3.3 ± 0.7	3 ± 0.9	0.08
Postoperative myocardial infarction, n (%)	4 (15%)	2 (7%)	0.11
Postoperative stroke, n (%)	1 (3.8%)	1 (3.9%)	1.00
Postoperative acute renal dysfunction, n (%)	4 (15%)	5 (18%)	0.7
Hemodialysis (%)	0 (0%)	0 (0%)	1.00
Postoperative acute atrial fibrillation (%)	5 (19%)	3 (11%)	0.16
Time of icu stay(days)	3.3 ± 0.6	3.4 ± 1.4	0.78

CPB - Cardiopulmonary Bypass, ICU - Intensive Care Unit treatment. p > 0.05 for all data.

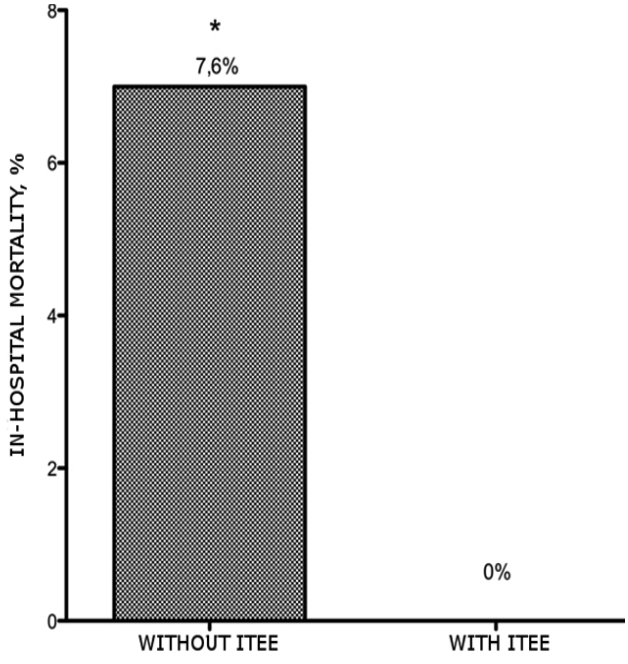

Figure 2 - *In-hospital mortality between Groups.*

patients, concluded that the use of ITEE decreased mortality and morbidity in patients undergoing on-pump procedures[4] and the ITEE should be used routinely in cardiac operations[3].

In this study, the group that used the ITEE had a lower ejection fraction in the preoperative period. Since the lower the ventricular function the higher the mortality, we expected a higher morbidity and mortality in this group 6. However, the results showed that the ITEE group, despite having a lower preoperative ejection fraction, had lower in-hospital mortality. The same result was demonstrated by Savage *et al.* [3] and Silva *et al.* [4].

As the left ventricular function results from filling and emptying of the left ventricle, both systolic and diastolic function, they may solely compromise cardiac performance (systolic-diastolic evaluation) [13]. Therefore, the use of ITEE can guide the best treatment, optimizing the LV systolic and diastolic functions during CABG [3,4,16].

It has been shown that the use of ITEE in CABG can optimize volume replacement therapy in 47% of cases. Moreover, ITEE alone was the monitor that most positively influenced in decision making regarding the use of inotropes, vasodilators and volume replacement [3,4,16].

According to the American Society of Cardiovascular Anesthesia, over 72% of anesthesiologists who work with cardiac anesthesia use ITEE routinely. Furthermore, ITEE provides 12.8% of new information and may change surgical approach in up to 48% of cases [3,4,16].

In the present study, although there was no difference in morbidity between the two groups, we can observe a trend towards a lower incidence of perioperative myocardial infarction and atrial fibrillation in the ITEE group. These results were also observed by Savage et al. in a prospective study with 82 patients [3].

The limitations of this study were the small number of patients studied and the lack of randomization of the sample, which do not allow us to extrapolate this analysis to the general population. To confirm these results, it would be important to conduct further randomized, prospective studies, with larger samples.

The use of intraoperative transesophageal echocardiography in patients undergoing coronary artery bypass grafting with cardiopulmonary bypass decreased perioperative mortality, guided on the use of inotropic drugs and vasodilators and contributed to a better patient outcome.

R E S U M O

Objetivo: *avaliar as taxas de mortalidade e morbidade de doentes submetidos à revascularização do miocárdio (RVM) com circulação extracorpórea (CEC) que utilizaram rotineiramente o ecocardiograma transesofágico intraoperatório (ETEio).* ***Métodos:*** *estudo retrospectivo, observacional com avaliação de prontuários de 360 doentes no período entre abril de 2010 a abril de 2012. Foram analisados: idade, peso, altura sexo, EUROscore, diabete melito, fração de ejeção e artérias acometidas. Os desfechos foram compilados no intra e no pós-operatório (infarto do miocárdio, acidente vascular cerebral, disfunção renal, hemodiálise, fibrilação atrial, tempo de internação no centro de tratamento intensivo).* ***Resultados:*** *foram incluídos 53 doentes, com 27 recebendo a monitoração. Foram excluídos 307 porque não foram operados pela mesma equipe cirúrgica. Os dois grupos foram homogêneos quanto a idade, peso e sexo, porém, a fração ejeção foi menor no grupo que recebeu o ecotransesofágico (G ETEio: 56,3%; G Não ETEio: 65,9% ± 11;* p=*0,01). Nos doentes em que não foi utilizado o ETEio, a mortalidade foi maior (G ETEio: 0% e G Não ETEio: 7,6%;* p=*0,01). Não houve diferença significativa entre os grupos quanto à incidência de acidente vascular encefálico, infarto agudo do miocárdio, fibrilação atrial aguda e lesão renal.* ***Conclusão:*** *a utilização do ecocardiograma transesofágico intraoperatório em pacientes submetidos à revascularização do miocárdio, com circulação extracorpórea, diminuiu a mortalidade perioperatória; orientou quanto a utilização dos fármacos inotrópicos e vasodilatadores e contribuiu para uma melhor evolução dos doentes.*

Descritores: *Ecocardiografia transesofagiana. Procedimentos cirúrgicos cardíacos. Circulação extracorpórea. Cardiotônicos. Vasodilatadores.*

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Address correspondence to:
Marcello Fonseca Salgado Filho
E-mail: mfonsecasalgado@hotmail.com