ORIGINAL ARTICLE

Coronary Artery Bypass Grafting in Argentina. Subanalysis of the ARGEN-CCV Registry

Cirugía de revascularización miocárdica en Argentina. Subanálisis del Registro ARGEN-CCV

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ABSTRACT

Background: Coronary artery bypass grafting (CABG) continues to be widely used to treat coronary artery disease, mainly in patients with technical difficulties in performing angioplasty, as well as in patients with diabetes mellitus. CABG data from the ARGEN-CCV registry are presented. This registry shows the current data on cardiovascular surgery (CVS) in Argentina.
Objective: To determine the in-hospital course of patients undergoing CABG.
Methods: ARGEN-CCV is a prospective, multicenter registry of patients undergoing CVS in Argentina, from which peripheral vascular surgery and repair of congenital heart disease were excluded. For this analysis, only patients who underwent CABG were analyzed.
Results: A total of 700 patients were included. Seventy percent (70%) were elective surgeries, and extracorporeal circulation (ECC) was used in 50.6% of the cases. In total, 38.6% of patients were diabetic, 22.4% had a history of left ventricular dysfunction and 38.1% had left main coronary artery disease. The left internal mammary artery to the left anterior descending artery graft was the most commonly used (94.6%). The recorded mortality was 6.9% and in patients with left ventricular dysfunction it was 13.1% vs. 5.1% in the rest ($p<0.001$). In the multivariate analysis 3 post-surgical variables, inotropic use, low cardiac output syndrome and renal failure, were predictors of mortality, strongly influenced by a history of left ventricular dysfunction.
Conclusion: We observed a high percentage of patients with diabetes and patients with left main coronary artery disease as well as high surgical morbidity and mortality, particularly in those patients with left ventricular dysfunction.

Keywords: Registry - Cardiovascular surgery - Coronary artery bypass grafting

RESUMEN

Introducción: La cirugía de revascularización miocárdica (CRM) continúa siendo ampliamente utilizada para tratar la enfer¬medad coronaria, fundamentalmente en pacientes que plantean dificultades técnicas para realizar angioplastia, así como en pacientes con diabetes mellitus. Se presentan los datos de CRM del registro ARGEN-CCV, que muestra los datos actuales de la cirugía cardiovascular (CCV) en Argentina.
Objetivo: Conocer la evolución intrahospitalaria en pacientes sometidos a CRM.
Material y métodos: ARGEN-CCV es un registro prospectivo, multicéntrico de pacientes sometidos a CCV en Argentina, del que se excluyeron las cirugías vasculares periféricas y la reparación de cardiopatías congénitas. Para este análisis se analizaron solo los pacientes sometidos a CRM.
Resultados: Se incluyeron 700 casos. El 70 % fueron cirugías programadas y en el 50,6 % se usó circulación extracorpórea (CEC). Tenía diabetes el 38,6 % de los pacientes, 22,4 % tenía antecedente de disfunción ventricular izquierda y 38,1 % lesión de tronco de coronaria izquierda. El puente mamario izquierdo a la arteria descendente anterior (DA) fue el más utilizado (94,6 %). La mortalidad registrada fue de 6,9 % y en los casos con disfunción ventricular izquierda fue de 13,1 % vs 5,1 % en el resto ($p<0,001$). En el análisis multivariado 3 variables postquirúrgicas, uso de inotrópicos, síndrome de bajo gasto cardíaco e insuficiencia renal, fueron predictores de mortalidad, fuertemente influidos por el antecedente de disfunción ventricular izquierda.
Conclusión: Se observó un porcentaje elevado de pacientes diabéticos, con enfermedad del tronco de la coronaria izquierda y alta morbimortalidad quirúrgica, especialmente en aquellos con disfunción ventricular izquierda.

Palabras clave: Registro - Cirugía cardiovascular - Revascularización miocárdica

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INTRODUCTION

Coronary artery disease is a well-known cause of morbidity and mortality worldwide, which has led to the search for medical and surgical advances in its management, showing good outcomes and implications on life expectancy. (1,2)

In recent years, percutaneous coronary intervention has gained ground, but coronary artery bypass grafting (CABG) is still widely used, even more so in patients with technical difficulties in performing coronary angioplasty and in those with diabetes mellitus, given its good long-term prognosis. The efficacy and safety of the procedure are related to the experience of the surgical teams and centers. Together with the control of cardiovascular risk factors and medical treatment of coronary artery disease, it is undoubtedly a procedure with a positive impact on survival and quality of life. (3-5)

Currently, there are some clinical tools to assess the indication and potential risks and benefits of a procedure such as a CABG and to make a rational decision. The European System for Cardiac Operative Risk Evaluation (EuroSCORE II) and the score of the Society of Thoracic Surgeons (STS) are tools developed based on clinical variables to assess the risk of in-hospital and 30-day mortality. We also have the ArgenSCORE, a predictive method developed in Argentina. (6-9)

In addition, it is necessary to know the mortality rate of this procedure at a local level, which, together with the above-mentioned tools, will allow an adequate decision-making threshold to be established. It is also important to gather all the factors that may cause poor and undesirable postoperative outcomes, so it is necessary to identify the variables that have a negative impact on prognosis and thus adjust the provision of health services. (10,11)

OBJECTIVES

This analysis aimed to determine the in-hospital course of patients who underwent CABG in a registry of cardiovascular surgery in Argentina (ARGEN-CCV) and the preoperative, operative, and immediate postoperative factors associated with in-hospital mortality.

METHODS

A multicenter, cross-sectional study was carried out, including patients over 18 years of age admitted to hospital for an elective or emergency cardiovascular surgery (CVS). Preoperative, operative and postoperative data were obtained during hospitalization. Surgeries for repair of congenital heart disease and peripheral procedures were excluded. This project was conducted by the Argentine Society of Cardiology and the Argentine College of Cardiovascular Surgeons, and was promoted as the National Registry of Cardiovascular Surgery in Argentina (ARGEN-CCV). A total of 1515 patients were included in 48 public and private centers in Argentina for a 13-month period, between July 2021 and August 2022. The project was registered in ClinicalTrials.gov NCT0519916. For this analysis, 700 cases with CABG were exclusively considered, and the other categories as well as combined surgeries were excluded.

Statistical analysis

Continuous variables were expressed as mean and standard deviation for those with normal distribution and as median and interquartile range (IQR) 25%-75% for those with non-Gaussian distribution. Qualitative variables were expressed as percentages. Comparisons between groups were performed using Student's t-test or Wilcoxon test according to the distribution for continuous data, and 2x2 tables were used, as well as the chi-square test with Yates' continuity correction for categorical variables. A p level <0.05 was considered significant. Uni- and multivariate logistic regression analyses were performed to identify independent variables of mortality, mortality, with their odds ratio (OR) and 95% confidence interval (95% CI). The Hosmer-Lemeshow test and the ROC curve were calculated for the corresponding model. Data were collected in REDCap and the analysis was performed with R software. (12,13)

Ethical considerations

The study was approved by the Ethics Committee of the Argentine Society of Cardiology.

RESULTS

A total of 700 patients who underwent exclusively CABG were included. In total, 70% of the surgeries were elective, 28% were emergencies and 2% were urgencies. The mean age was 64 ± 9.5 years; 16.3% were female, 81.4% had arterial hypertension, 38.6% diabetes mellitus, 42.3% acute myocardial infarction, 18.9% previous angioplasty and 22.4% some degree of left ventricular dysfunction. The most frequently affected vessels were the left anterior descending artery (95.3%), the circumflex artery (77%), the right coronary artery (71.6%) and the left main coronary artery (38.1%). Table 1 shows the main preoperative variables. In 93% of the cases, at least two bypasses were performed, and extracorporeal circulation (ECC) pump was used in 50.6% of them, with a median of 90 minutes (IQR 70-110); the median aortic clamping time was 50 minutes (IQR 25-74), the rest of the preoperative variables are shown in Table 2.

Regarding the main postoperative complications, the use of inotropic drugs was observed in 69.3% of the cases, being noradrenaline (85%) the most commonly used drug; atrial fibrillation was observed in 21.3%, low cardiac output syndrome in 12.6%, and bleeding in 8.3%. Overall in-hospital mortality was of 6.9% and the median number of inpatient days was 8 (IQR 6-13) (Table 3). In patients with a history of left ventricular dysfunction, in-hospital mortality was 13.1% compared to 5.1 % in those without it ($p<0.001$).

The mortality predictors in the univariate analysis are shown in Table 4. In the multivariate logistic regression model, the following postoperative variables were identified: use of inotropic drugs (OR 6.11; $p=0.015$), low cardiac output syndrome (OR= 3.09; $p=0.003$) and renal failure (OR= 5.76; $p=< 0.001$) (Table 5). Several variables known to have an impact on mortality, such as age, ECC time and aortic clamping

Table 1. Main preoperative variables

	n=700
Age, years, mean (SD)	64 (9.5)
Female, %	16.3
Cardiovascular risk factors	
Arterial hypertension, %	81.4
Diabetes mellitus, %	38.6
Dyslipidemia, %	64.7
Active smoking, %	22.4
Hereditary family history of coronary artery disease, %	14.9
Cardiovascular history	
Stable chronic angina, %	18.4
Heart failure, %	10.1
Acute myocardial infarction, %	42.3
CABG, %	6.7
Coronary angioplasty, %	18.9
Atrial fibrillation, %	4.6
Left ventricular dysfunction, %	22.4
Peripheral vascular disease, %	12.7
Stroke, %	5.1
Obstructive sleep apnea, %	3
COPD (moderate and severe), %	16.3
Reason for consultation	
Dyspnea, %	33.1
Precordial pain, %	81.4
Syncope, %	2.4
Acute pulmonary edema, %	2.3
Tachyarrhythmia, %	2
Involved coronary vessels	
Left main coronary artery, %	38.1
Left anterior descending artery , %	95.3
Left diagonal artery, %	23.4
Left circumflex artery, %	77
Lateral ventricular artery, %	10.6
Right coronary artery, %	71.6
Preoperative complexity	
Use of intra-aortic balloon counterpulsation, %	2.9
Use of Swan-Ganz catheter, %	1.7
Use of inotropic drugs, %	2.1
Mortality risk scores	
EuroSCORE II, median (IQR)	1.3 (0.8-2.4)
ArgenSCORE, median (IQR)	2.8 (1.8-5.8)

CABG: coronary artery bypass grafting; COPD: chronic obstructive pulmonary disease;
IQR: interquartile range 25-75%; SD: standard deviation

Table 2. Intraoperative variables

	n=700
Distal beds	
Good, %	42.6
Regular, %	49.3
Bad, %	7.9
Operative times	
ECC time in minutes, median (IQR)	90 (70-110)
Aortic clamping time in minutes, median (IQR)	50 (25-74)
Use of ECC, %	50.6
Coronary artery bypass grafts	
Left internal mammary artery to left anterior descending artery, %	94.6
Right internal mammary artery to right coronary, %	24.4
Radial artery graft, %	4.4
Venous graft, %	80.1
Endarterectomy, %	2.3
Intraoperative complications	
Hemorrhage, %	4.3
Intraoperative cardiac arrest, %	1.6
Re-entry into ECC, %	0.9

ECC: extracorporeal circulation; IQR: interquartile range 25-75%.

Table 3. Postoperative data

	n=700
Intubated patients admitted to the recovery room, %	53
Low cardiac output syndrome, %	12.6
Need for inotropic drugs, %	69.3
Need for Swan-Sanz catheter, %	9.1
Postoperative infarction, %	3.3
Atrial fibrillation, %	21.3
Atrioventricular block, %	2.3
Complex ventricular arrhythmia, %	1.7
Temporary pacemaker, %	16
Permanent pacemaker, %	1.4
Renal failure, %	12.1
Bleeding, %	8.3
In-hospital mortality, %	6.9
Inpatient days, median (IQR)	8 (6-13)

IQR: interquartile range 25-75%.

time, bleeding and others were explored but they were not found to be statistically significant in this cohort. The history of left ventricular dysfunction, which was significant in the univariate analysis, was not significant in the multivariate analysis: its OR significantly modified the rest of the variables when included in the model. This suggests that it is a confounder, and that in the patients who developed these complications, this is probably explained by the fact that most of them were those who had a history of ventricular dysfunction. The area under the curve of this model was 0.79 (95% CI 0.72-0.85) (Figure 1). The Hosmer-Lemeshow test yielded a value of p= 0.738.

DISCUSSION

The ARGEN-CCV registry shows the results of cardiovascular surgery in Argentina after a decade since the last CONAREC XVI registry in 2010. Compared

Tabla 4. Univariate logistic regression model, mortality predictors.

Mortality predictors	OR	95% CI	p
Age	1.05	102-1.09	<0.001
History of left ventricular dysfunction	2.82	1.52-5.16	<0.001
Surgery without ECC	1.97	1.07-3.75	0.033
Clamping time	0.98	0.97-0.99	0.009
Postoperative use of inotropic drugs	10.73	3.27-66.13	<0.001
Postoperative low cardiac output syndrome	7.63	4.05-14.30	<0.001
Postoperative renal failure	9.23	4.91-17.44	<0.001

Tabla 5. Multivariate logistic regression model, mortality predictors

Mortality predictors	OR	95% CI	p
History of left ventricular dysfunction	1.12	0.53-2.32	0.751
Postoperative use of inotropic drugs	6.11	1.76-38.56	0.015
Postoperative low cardiac output syndrome	3.09	1.45-6.51	0.003
Postoperative renal failure	5.76	2.85-11.54	<0.001

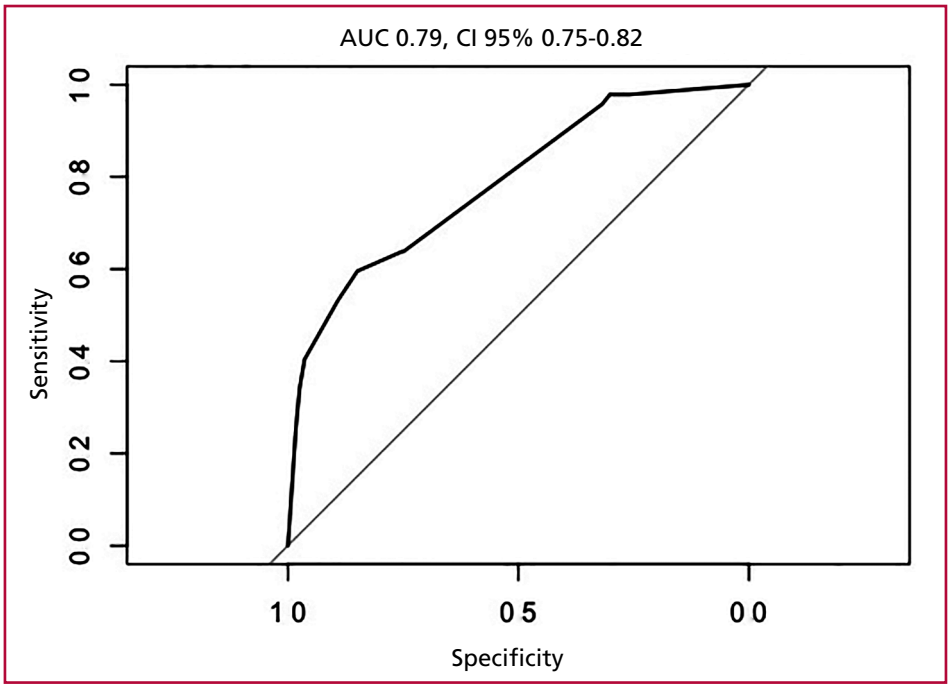

Fig. 1. Mortality prediction model. ROC curve.

AUC: area under the curve

to the previous registries, CONAREC III in 1993 and ESMUSICA in 1997, we can observe the advances in cardiovascular surgery in the last almost 30 years, with improvements in the materials used, new surgical techniques and an increasing number of patients undergoing CABG after being excluded from percutaneous procedures. (14-16)

This registry shows a high prevalence of diabetic patients (38.6%) compared to previous registries where the highest percentage reported was 30.4% (CONAREC XVI), showing the worrying progression of this well-known cardiovascular risk factor. (17) In terms of anatomy, 38.1% had severe involvement of the left main coronary artery, which is also the highest locally reported to date.

The most widely used grafts were the left mammary artery graft, followed by the vein graft, the right mammary artery graft and, to a lesser extent, the radial artery graft with almost half of the patients undergoing surgery without ECC.

During hospitalization, with a median of 8 days, a high use of inotropic drugs was observed, being noradrenaline the most commonly used. This drug is used to elevate blood pressure, mainly in the first hours of the patients' recovery, when greater lability is observed. This does not appear to reflect a genuine situation of low cardiac output syndrome, in which drugs with greater cardiotonic power such as dobutamine are used. Almost half of the patients were admitted to the recovery room extubated. Atrial fibrillation was the most frequent complication, followed by low cardiac output syndrome, renal failure, and bleeding.

Overall in-hospital mortality was 6.9%, higher than that reported in the CONAREC XVI registry, which was 4.3% for the CABG group. However, when comparing patients with a history of ventricular dysfunction, we found two clearly different groups: the mortality of patients with a history of ventricular dysfunction exerts traction on the overall mortality, as it was 13.1% versus 5.1% in the rest of the patients; nevertheless, high mortality is observed in patients with good ventricular function. (18) Consistent with this observation, in the multivariate analysis, the variables that best predict mortality are related to left ventricular dysfunction. This particular group of patients undoubtedly has the worst prognosis. Although this type of outcome is within the expected range of possible complications, according to the surgical teams, the magnitude of data helps to reinforce the necessary precautions to seek tools to improve the prognosis since, as we know, in several cases surgery is the only technically possible option.

Two of the most widely used perioperative scores, EuroSCORE and ArgenSCORE, were also used in the registry population. Although this work does not seek to validate data from these scores, the mortality predicted by these tools was significantly lower than that observed, which is consistent with a similar behavior observed in other Latin American populations. (19)

In addition, it is very important to highlight that this study was carried out during a very specific period in the history of the world health system and, therefore, in Argentina: the COVID-19 pandemic caused by SARS-Cov-2. It is difficult to isolate the context to evaluate the outcomes; specifically, the patients were enrolled in the registry during the period known as DISPO (preventive and mandatory social distancing) established by the National Executive Power, which had direct consequences on social behavior and affected the dynamics of the health system. As is well known from local and international reports, there was a decrease in the number of cardiology consultations by the population, many centers were converted to meet the demand for COVID-19 and health personnel experienced a saturation that complicated routine care. (20,21)

In spite of this, the ARGEN-CCV registry was able to be conducted and provided us with data on the reality in context, more than a decade after the last multicenter registry in Argentina.

One of the weaknesses of this registry was that the data obtained in both public and private centers, despite the considerable number compared to previous registries, may not reflect the reality of all the institutions, and a greater participation of centers and number of cases may be necessary to validate or refute the results.

CONCLUSION

In the ARGEN-CCV registry, in patients undergoing coronary artery bypass grafting we observed a higher percentage of diabetic patients and patients with left main coronary artery disease than in previous local registries. Despite the years that have elapsed since the last coronary artery bypass grafting registry, there is evidence of persistent surgical morbidity and mortality, particularly in patients with left ventricular dysfunction.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web).

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