Perioperative myocardial infarction in patients undergoing myocardial revascularization surgery

Infarto do miocárdio perioperatório em pacientes submetidos à cirurgia de revascularização miocárdica

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Abstract

Introduction: Perioperative myocardial infarction adversely affects the prognosis of patients undergoing coronary artery bypass graft and its diagnosis was hampered by numerous difficulties, because the pathophysiology is different from the traditional instability atherosclerotic and the clinical difficulty to be characterized.

Objetive: To identify the frequency of perioperative myocardial infarction and its outcome in patients undergoing coronary artery bypass graft.

Methods: Retrospective cohort study performed in a tertiary hospital specialized in cardiology, from May 01, 2011 to April 30, 2012, which included all records containing coronary artery bypass graft records. To confirm the diagnosis of perioperative myocardial infarction criteria, the Third Universal Definition of Myocardial Infarction was used.

Results: We analyzed 116 cases. Perioperative myocardial infarction was diagnosed in 28 patients (24.1%). Number of grafts and use and cardiopulmonary bypass time were associated with this diagnosis and the mean age was significantly higher in this group. The diagnostic criteria elevated troponin I, which was positive in 99.1% of cases regardless of diagnosis of perioperative myocardial infarction. No significant difference was found between length of hospital stay and intensive care unit in patients with and without this complication, however patients with perioperative myocardial infarction progressed with worse left ventricular function and more death cases.

Conclusion: The frequency of perioperative myocardial infarction found in this study was considered high and as a consequence the same observed average higher troponin I, more cases of worsening left ventricular function and death.

Descriptors: Myocardial Infarction. Myocardial Revascularization. Postoperative Complications. Troponin I.

Resumo

Introdução: O infarto do miocárdio perioperatório afeta negativamente o prognóstico dos pacientes submetidos à cirurgia de revascularização do miocárdio e seu diagnóstico esbarra em inúmeras dificuldades, pois a fisiopatologia é diferente da tradicional instabilidade aterosclerótica e o quadro clínico de difícil caracterização.

Objetivo: Identificar a frequência de infarto do miocárdio perioperatório e seu desfecho em pacientes submetidos à cirurgia de revascularização do miocárdio.

Métodos: Coorte retrospectiva realizada em hospital terciário especializado em cardiologia, de 1 de maio de 2011 a 30 de

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Abbreviations, acronyms & symbols	
AMI	Acute myocardial infarction
CABG	Coronary artery bypass graft
CAD	Coronary artery disease
CLAMP	Coronary lesion, surgical time and length of clamping
CPB	Cardiopulmonary bypass
ECG	Electrocardiogram
IECAC	Instituto Estadual de Cardiologia Aloysio de Castro
LBBB	Left bundle branch block
LV	Left ventricle
LVEF	Left ventricle ejection fraction
PMI	Perioperative myocardial infarction

abril de 2012, que incluiu todos os prontuários contendo registros de cirurgia de revascularização do miocárdio. Para confirmação diagnóstica do infarto do miocárdio perioperatório, foram utilizados os critérios da *Third Universal Definition of Myocardial Infarction*.

Resultados: Foram analisados 116 casos. Foi diagnosticado infarto do miocárdio perioperatório em 28 pacientes (24,1%). Número de enxertos e utilização e tempo de circulação extracorpórea foram fatores associados a este diagnóstico e a média de idade foi significativamente mais elevada neste grupo. O critério diagnóstico elevação de troponina I foi positivo em 99,1% dos casos, independentemente do diagnóstico de infarto do miocárdio perioperatório. Não foi encontrada diferença significativa entre tempo de internação hospitalar e em unidade de terapia intensiva nos grupos com e sem esta complicação, porém pacientes com infarto do miocárdio perioperatório evoluíram com pior função ventricular esquerda e mais casos de óbito.

Conclusão: A frequência de infarto do miocárdio perioperatório encontrada neste trabalho foi considerada alta e como consequência do mesmo observou-se média mais elevada de troponina I, mais casos de piora da função ventricular esquerda e óbito.

Descritores: Infarto do Miocárdio. Revascularização Miocárdica. Complicações Pós-Operatórias. Troponina I.

INTRODUCTION

The coronary artery bypass graft (CABG) is very frequent. It aims to relieve symptoms caused by coronary artery disease (CAD), protect the ischemic myocyte, improve ventricular function, prevent acute myocardial infarction (AMI) and prolong life as well as its quality[1].

In the last three decades, a better understanding of the pathophysiology of atherosclerotic disease and advances in technology and surgical technique, promoted the reduction of the consequent complications to CABG. It was observed that even small atherosclerotic plaques can evolve into important and limiting lesions of the coronary flow and that any board can suffer rupture and can cause an acute event. Considering the operating framework, to perform procedures without cardiopulmonary bypass (CPB) and use of arterial grafts are the most relevant contribution[1,2].

Despite these improvements, the surgical treatment of coronary disease have been performed in patients with increasingly complex lesions and with more comorbidities, which has resulted in increased incidence of postoperative complications[3].

In cardiovascular surgery, perioperative myocardial infarction (PMI) is a complication that adversely affects the prognosis of patients, and their pathophysiology may be different from the traditional instability of atherosclerotic plaque[4,5]. In general, it happens secondary to hypotension, inadequate myocardial protection during surgery, technical factors related to anastomosis and hypovolemia during procedures and in the postoperative period[3].

The diagnosis of PMI has its particularities. Its characterization may be difficult, especially in the first hours after surgery, when you cannot get the patient's report, which may be under tracheal intubation, present changes in cognition by residual anesthetic effect or confuse it with the pain generated by the chest wall incision, through drains or pericardium with ischemic pain[5].

This cohort study aims to identify the frequency of PMI and its outcome in patients undergoing CABG surgery in a hospital specialized in cardiology.

METHODS

This is a retrospective cohort study conducted at the Instituto Estadual de Cardiologia Aloysio de Castro (IECAC), in the city of Rio de Janeiro, developed between May 1, 2011 and April 30, 2012.

All records of medical files containing isolated or associated cardiac surgeries performed in the period described above were included.

Patients who did not have a recorded echocardiogram, and those who performed pre and postoperative electrocardiogram (ECG), preoperative troponin I and seriated on the postoperative period, and those with illegible or incomplete records were excluded from the study.

To confirm the diagnosis of PMI the following criteria were adopted: elevated troponin greater than ten times the 99th percentile in patients with normal baseline; associating to a new pathological Q wave or new left bundle branch block (LBBB) on ECG or coronary angiography showing occluded graft or native vessel or image test showing loss of viable myocardium or new abnormal segmental movement[6]. Paradoxical septal motion on echocardiography was not considered an element belonging to the previous criteria as it happens after cardiac surgery without necessarily being secondary to ischemic response[7].

The test used to determine the level of troponin I in serum or plasma was VIDAS® Ultra Troponin I (TNIU) by ELFA technique (EnzymeLinked Fluorescent Assay). The value was considered normal when less than 0.01 µg/L (as bull test) [8]. The dosage, for all patients, was performed before CABG (basal troponin) at the time of admission at the intensive care unit, 12 and 24 hours after the procedure.

The results of echocardiographic studies used for the analysis of global and segmental function of the left ventricle (LV), performed at times by different and experienced examiners, were transferred to individual spreadsheets and divided into seventeen segments, as requested by the Comittee of Cardiological Images from the Council on Clinical Cardiology of the American Heart Association[9]. The left ventricle ejection fraction (LVEF) was considered normal if greater than 55% and abnormal when between 54 and 45% (mild dysfunction), between 44 and 30% (moderate dysfunction) and less than 30% (severe dysfunction) according to the Guidelines recommendations for quantifying cardiac chambers[10].

All patients underwent surgical treatment with a technique involving median sternotomy transsternal. CPB was performed with moderate core hypothermia (32˚C-34˚C) and myocardial protection was established by means of hypothermic blood cardioplegia (4˚C), infused into the aortic root or directly into the coronary sinus. All patients received a balanced closed loop absorber veno inhalationed general anesthesia, with CO_2 (Soda Lime) absorber and mechanical ventilation. The inhalational agent isoflurane with 50% oxygen mixed with nitrous oxide was used as an inhaler agent. As venous drugs, the hipnotics etomidate and midazolam; as opiod, fentanyl; and as muscle relaxant, pancuronium bromide were used[11].

This study was approved by the IECAC Research Ethics Committee, registered in Brazil under the Platform number 0328411112.0.0000.5265.

Data were stored and analyzed using Epi Info™ version 3.5.3 program. It was used the Fisher exact test to demonstrate association between qualitative variables and the Kruskal-Wallis test to compare the means. They were considered statistically significant when $P<0.05$.

RESULTS

A hundred and thirty-eight CABG procedures were listed in the medical files, 22 of which were excluded, one by treating it exclusively of valve surgery, 10 due to incomplete records and 11 records were not located, with a final sample comprised of 116 cases.

PMI was diagnosed in 28 (24.1%) patients and the variable mean age was significantly higher in this group. The overall profile of the sample, separated by groups (with and without PMI) and its epidemiological characteristics, are in Table 1.

The reoperation occurred in one patient and he did not receive a diagnosis of PMI.

The number of grafts, usage and CPB time were factors associated with a diagnosis of PMI. However, incomplete revascularization, emergency surgery, cardiac surgery associated, type of coronary lesion, surgical time and length of clamping (CLAMP) of the aorta were similar between groups (Table 2).

A new Q wave on the electrocardiogram was observed in 11 cases (9.5%) and LBBB in 10 (8.6%). The paradoxical interventricular septum movement was reported in 25% of echocardiograms performed after CABG.

In the comparison between the groups with and without a diagnosis of PMI, no significant difference was found regarding the hospitalization time and intensive care unit after CABG (Table 3).

The elevation of the troponin I level above ten times the 99th percentile was demonstrated in 99.1% of the measurements performed after CABG. Their levels were significantly higher in patients undergoing surgery with CPB ($P<0.00$) and in those who died ($P=0.01$). Mean troponin I in patients who died was 11.3 µg/L and those who survived 2.9µg/L. When analyzing the mean troponin I in the group with and without PMI, it was found 1.1µg/L in the former and 7.4 µg/L in the latter.

Table 1. Profile of the sample and epidemiological characteristics.

| Variables | Total sample (n=116) | | | With PMI (n=28) | | | Without PMI (n=88) | | | |
	n	mean±SD	%	n	mean±SD	%	n	mean±SD	%	P value
Female	33	-	28.4	10	-	35.7	23	-	26.1	0.22*
Age	-	60.8±8.9	-	-	65.2±7.6	-	-	59.4±8.9	-	0.00†
Hypertension	98	-	84.5	25	-	89.3	73	-	83	0.31*
DM	41	-	35.3	12	-	42.9	29	-	33	0.23*
Current smoking	35	-	30.2	11	-	39.3	24	-	27.3	0.19*
Dyslipidemia	44	-	37.9	11	-	39.3	33	-	37.5	0.51*
Severe dysfunction of the LV	8	-	6.8	0	-	0	8	-	9.1	0.10*

PMI= perioperative myocardial infarction; DM=type 2 diabetes mellitus; LV=left ventricle; SD=standard deviation; (*) Fisher exact test; (†) Kruskal-Wallis test

Table 2. Surgical characteristics of the sample.

Variables	Total sample (n=116)			With PMI (n = 28)			Without PMI (n=88)			P value
	n	mean±SD	%	n	mean±SD	%	n	mean±SD	%	
Emergency surgery	11	-	9.5	2	-	7.1	9	-	10.2	0.47†
Cardiac surgery associated	8	-	6.9	2	-	7.1	6	-	6.8	0.45†
Triple vessel coronary lesion	56	-	48.3	18	-	64.3	38	-	43.2	0.04†
Lesions of the LMCA	20	-	17.2	3	-	10.7	17	-	19.3	0.22†
Number of grafts	-	2.8±1.0	-	-	3.3±0.9	-	-	2.7±1.0	-	0.01‡
Use of CPB	100	-	86.2	28	-	100	72	-	81.8	0.00†
CPB time*	-	86.3±26.7	-	-	96.5±27.2	-	-	82.4±25.6	-	0.01‡
Length of aortic clamping*	-	61.5±22.7	-	-	67.2±24.7	-	-	59.3±21.7	-	0.19‡
Surgical time*	-	237.4±63.7	-	-	260.6±71.7	-	-	230.1±59.6	-	0.20‡

PMI=perioperative myocardial infarction; LMCA=left main coronary artery; CPB=cardiopulmonary bypass; SD=standard deviation; (*) time in minutes; (†) Fisher exact test; (‡) Kruskal-Wallis test

Table 3. Variables related to perioperative myocardial infarction.

Variables	Total sample (n=116)			With PMI (n=28)			Without PMI (n=88)			P value
	n	mean±SD	%	n	mean±SD	%	n	mean±SD	%	
Mean troponina I (µg/L)	-	3.1±4.4	-	-	7.4±6.8	-	-	1.8±1.8	-	0.00‡
Time on ICU*	-	5.3±4.2	-	-	5.2±2.7	-	-	5.3±4.6	-	0.66‡
Surgery – hospital discharge	-	14.8±11.0	-	-	16.0±10.4	-	-	14.4±11.3	-	0.26‡
Deterioration in LV function postoperative	20	-	17.2	14	-	50	6	-	6.8	0.00†
Intra aortic balloon	3	-	2.6	2	-	7.1	1	-	1.1	0.14†
Deaths	3	-	2.6	3	-	10.7	0	-	0	0.01†

PMI=perioperative myocardial infarction; LV= left ventricle; ICU=Intensive Care Unit; SD=standard deviation; (*) time in days; (†) Fisher exact test; (‡) Kruskal-Wallis test

Amongst the complications related to the PMI, we can name five degree atrioventricular blocks, a mural thrombus in LV and a vascular ischemic brain (associated with carotid endarterectomy combined with CABG), without any statistical significance. Signs of low cardiac output requiring intra-aortic balloon pump were observed in three cases, two (7.1%) in a group with PMI and one (1.1%) in the group without PMI (Table 3).

All deaths (3; 10.7%) occurred in the group with PMI, making this a significant finding (*P*=0.01) compared to patients without this complication.

DISCUSSION

The epidemiological characteristics of age and gender were similar to those described by Mohammed et al.[12]. According to Houlind et al.[13], age is an independent factor of serious complications after CABG, which is in agreement with the data of this study, once we found significantly higher age in the group with PMI.

In this cohort the prevalence of hypertension and diabetes was high, as well as that described by Jagger et al.[14]. Mohammed et al.[12] described in their study fewer smokers and more dyslipidemia regarding the data from this sample.

This study found 24.1% of PMI, above the value found by Jagger et al.[14] - 14%; and by Díaz Arrieta et al.[5] - 15%; but within 2 to 30% in the literature. This difference can be attributed to different criteria used in the diagnosis, as quoted by Díaz Arrieta et al.[5].

The average length of hospitalization of patients in this work contributed negatively to the means of the county and state of Rio de Janeiro (Table 4)[15]. This greater permanence can be explained, at least partially, by the fact that IECAC have undergone renovations in June and July 2011, during which there was a CABG per month, a very small number when compared to the 11.4 procedures done in the months in which there was not this impediment.

Mohammed et al.[12] reported that after CABG, 98% of patients had elevation more than 10 times the 99 percentile of troponin T, a fact that made them question the value arbitrarily assigned to this criterion for diagnosis of PMI. In the present study, while dosing troponin I, the same data was reproduced by finding these levels in 99.1% of the revascularized patients.

Table 4. Length of hospital stay and hospital mortality by place of occurrence, May 2011 to April 2012.

Place	Number of hospitalizations	Days of stay	Average length of stay	Deaths
IECAC	116	4711	40.6	2.5
Rio de Janeiro city*	534	13920	26.1	8.2
Rio de Janeiro*	1241	22682	18.3	7.3

IECAC – Instituto Estadual de Cardiologia Aloysio de Castro; (*) source: www.datasus.com.br

The high levels in the CABG postoperative troponin do not always represent myocardial ischemia and may be caused by mechanical damage related to the procedure. However, it is known that its levels are linearly related to worse prognosis[16]. In this study's sample, the mean serica dosage of troponin, both the PMI group and for the group that evolved to death, was significantly higher. There is evidence in the literature that biomarkers are significantly higher in surgery with CPB[6,17], and it is consistent with that found in this research.

It is estimated that about 25% of CABG in the United States do not use CPB, value above the one found in this sample (13.8%)[17]. Evidences show that patients operated with CPB have a higher incidence of this complication and IMP is also directly related to the duration of CPB[14,18]. These findings were also obtained in this research.

In the sample analyzed, when compared the anatomical alterations, it was found that both the three-vessel disease (significantly more common in the group with PMI) as the disease of the left main coronary artery (LMCA) are not independent predictors of PMI. However, it could be argued that injury in LMCA is related to the higher prevalence of PMI[14].

It may be noted that in this study there was a direct relationship between high number of grafts and the prevalence of PMI, a correlation previously reported by other authors[14]. This fact can be justified by a direct trauma to the myocardium, heart manipulation and surgical time, factors that may be related to myocardial injury and necrosis after CABG[6].

According to Pomerantzeff et al.[18], PMI is more common in patients who did not undergo elective surgery, unlike the data analyzed in this study, where this diagnosis was proportionately lower.

Despite being reported a higher incidence of PMI in CABG combined with other cardiac surgery[19], this association was not found in this study.

The incomplete revascularization was not significantly more common in the group with PMI, opposing the findings by Pomerantzeff et al.[18].

As reported by López Mora & Fiscal López[3], it was observed in this study that developed heart failure in post CABG is related to the PMI.

Brick et al.[1] reported increased risk of death in patients with PMI. In this study, death was significantly more prevalent in the group with this complication.

Concerning the mortality rate, at the IECAC it was 2,5%, what positively stands out in comparison to the municipal and state rates, that have approximately three times higher indices (Table 4).

The retrospective study has limitations such as the inability to standardize the echocardiographic analysis and loss of patients due to lack of data in the medical records. Despite of the inclusion of patients with procedures associated with CRM having the potential to contaminate the sample, it was thought to observe whether these cases were associated with the outcome of CABG.

CONCLUSION

The frequency of PMI found in this study (24.1%) was high since, in the literature, this rate varies from 2 to 30% depending on the diagnostic criteria used.

As a consequence of PMI it was observed that when the average of troponin is higher, more cases of worsening of the left ventricular function and death occur.

Authors' roles & responsibilities	
PP	Study design, collection, analysis and interpretation of data and manuscript writing
GFM	Study design, data interpretation and manuscript writing
AB	Study design, analysis and interpretation of data and manuscript writing
DDK	Interpretation of data and manuscript writing
BJ	Interpretation of data and manuscript writing

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