Journal of
Transcatheter Interventions
e-ISSN e-2595-4350

Clinical-angiographic profile and characteristics of percutaneous coronary interventions for thrombus-containing lesions

Perfil clínico-angiográfico e características das intervenções coronárias percutâneas nas lesões com trombo

Renato Sanchez Antonio[1iD], José Luis Attab dos Santos[1], Clemente Greguolo[2], José Fábio Fabris Júnior[2], Marcelo D'Anzicourt Pinto[2], Vicente Paulo Resende Júnior[3], Alan Nascimento Paiva[3], César Franco de Souza[4], Leandro Coumbis Mandaloufas[4], Márcio Alves Urzêda[5], Patricia de Godoy Bueno[1], Ricardo de Souza Alves Ferreira[1]

[1] *Hemodinâmica e Cardiologia Invasiva, Santa Casa de Misericórdia de São Sebastião do Paraíso, São Sebastião do Paraíso, MG, Brazil.*

[2] *Santa Casa de Misericórdia, Ribeirão Preto, SP, Brazil.*

[3] *Hospital das Clínicas Samuel Libânio, Pouso Alegre, MG, Brazil.*

[4] *Hospital Nossa Senhora da Abadia, Ituiutaba, MG, Brazil.*

[5] *Hospital Santa Mônica, Imperatriz, MA, Brazil.*

DOI: 10.31160/JOTCI201927A20190001

ABSTRACT – **Background:** Clinical outcomes of percutaneous coronary interventions depend on clinical, angiographic and procedure-related characteristics. The present study aimed to analyze patients with thrombus-containing lesions to study how the variables of interest influence in-hospital mortality. **Methods:** A retrospective study of procedures registered on the *Central Nacional de Intervenções Cardiovasculares* (CENIC) between 2006 and 2016, divided into three periods. **Results:** The sample comprised 22,587 patients. There were 22,978 procedures; in that, 25,107 vessels were treated, 23,237 (92.5%) of which with stents. The mean age of the patients was 60.9±12.1 years, 70.3% were male, and 20.5% diabetics. Of procedures, 93.8% were successful, 46.4% of which a primary intervention. Glycoprotein IIb/IIIa inhibitors were used in 15.3%, thromboaspiration in 4.3% and, drug-eluding stents were placed in 9.1% of cases. The variables that better explained mortality were the initial period of treatment, advanced age, female sex, absence of dyslipidemia, presence of diabetes, previous acute myocardial infarction, more extensive coronary artery disease, use of glycoprotein IIb/IIIa inhibitors and primary percutaneous coronary intervention in the multiple logistic regression model. **Conclusion:** The CENIC database was analyzed based on clinical, angiographic and procedure-related characteristics, as well as on clinical outcomes of percutaneous coronary interventions in patients with thrombus-containing lesions. Variables influencing in-hospital mortality were initial period, elderly, female, absence of dyslipidemia and diabetes, previous acute myocardial infarction, more extensive coronary artery disease, use of glycoprotein IIb/IIIa inhibitors and primary percutaneous coronary intervention.

Keywords: Coronary artery disease; Percutaneous coronary intervention; Mortality; Registries

RESUMO – **Introdução:** Os desfechos clínicos das intervenções coronárias percutâneas apresentam resultados dependentes das características clínicas, angiográficas e dos procedimentos. O objetivo deste estudo foi realizar a comparação dos pacientes com lesões e presença de trombo, para verificar a influência das variáveis de interesse em relação à mortalidade hospitalar. **Métodos:** Estudo retrospectivo de procedimentos cadastrados no registro da Central Nacional de Intervenções Cardiovasculares (CENIC) entre os anos 2006 e 2016, divididos em três períodos. **Resultados:** A amostra foi composta por 22.587 pacientes. Ocorreram 22.978 procedimentos, tendo sido tratados 25.107 vasos, sendo 23.237 (92,5%) com stents. A média de idades dos pacientes foi de 60,9±12,1 anos, 70,3% eram do sexo masculino, e 20,5% eram diabéticos. Com relação aos procedimentos, houve sucesso em 93,8%, sendo 46,4% de intervenção primária. O uso de inibidores da glicoproteína IIb/IIIa ocorreu em 15,3%, a tromboaspiração se realizou em 4,3% e, em 9,1%, implantou-se stent farmacológico. No modelo de regressão logística múltipla, as variáveis que melhor explicaram óbito foram primeiro período de tratamento, idade avançada, sexo feminino, ausência de dislipidemia, presença de diabetes, infarto agudo do miocárdio prévio, maior extensão da doença de artéria coronariana, uso de inibidores da glicoproteína IIb/IIIa e intervenção coronária percutânea primária. **Conclusão:** A análise do banco de dados da CENIC foi fundamentada nas características clínicas, angiográficas, dos procedimentos e desfechos clínicos nas intervenções coronárias percutâneas dos pacientes com lesões e presença de trombo.

How to cite this article:
Antonio RS, Santos JL, Greguolo C, Fabris Júnior JF, Pinto MA, Resende Júnior VP, et al. Clinical-angiographic profile and characteristics of percutaneous coronary interventions for thrombus-containing lesions. J Transcat Interven. 2019;27:eA20190001. https://doi.org/10.31160/JOTCI201927A20190001

Corresponding author:
Renato Sanchez Antonio
Praça Com. João Pio Figueiredo Westin, 92 – Centro
CEP: 37950-000, São Sebastião do Paraíso, MG, Brazil
E-mail: rsantonio255@gmail.com

Received on:
Feb 7, 2019

Accepted on:
Jun 10, 2019

Primeiro período de tratamento, idoso, sexo feminino, ausência de dislipidemia, diabetes, infarto agudo do miocárdio prévio, doença de artéria coronariana com maior extensão, uso de inibidores da glicoproteína IIb/IIIa e intervenção coronária percutânea primária foram variáveis que causaram repercussão na mortalidade hospitalar.

Descritores: Doença de artéria coronariana; Intervenção coronária percutânea; Mortalidade; Sistema de registros

BACKGROUND

Ischemic heart disease and stroke are the major causes of mortality worldwide, and they were accountable for a total 15.2 million out of 56.9 million deaths worldwide, in 2016.[1] Knowledge of clinical and angiographic characteristics of patients with coronary artery disease (CAD) is fundamental in making decisions regarding percutaneous coronary intervention (PCI), with an impact on quality of life and survival.[2]

Patients with non-ST segment elevation acute coronary syndrome (NSTEMI) usually present at least one culprit lesion, with eccentricity or irregular borders, and suggestive signs of ulcerations with luminal filling defects indicating adjacent thrombotic process.[3] The thrombotic burden in patients with ST-segment elevation myocardial infarction (STEMI), submitted to primary or rescue PCI, is considered a determining factor for negative clinical outcomes. The presence of thrombus-containing lesions is known to provide higher risk of major adverse cardiovascular events (MACE) and death, when compared to events without thrombus-containing lesions, due to higher risk for distal embolization, reduction in myocardial reperfusion and worse prognosis.[4]

In past decades, the development of interventional cardiology has allowed growth in PCI indication for more complex scenarios and patients. The present study aimed to compare the clinical-angiographic profiles and the characteristics of PCI performed on patients with thrombus-containing lesions, in order to study the influence of variables of interest on mortality.

METHODS

The present study is a retrospective analysis of clinical and angiographic characteristics, and post-PCI outcomes in a sample of 22,587 patients with thrombus-containing lesions, between June 2006 and March 2016. Data were collected from the *Central Nacional de Intervenções Cardiovasculares* (CENIC; http://www.corehemo.net/) of the *Sociedade Brasileira de Hemodinâmica e Cardiologia Intervencionista* (SBHCI). CENIC is an official agency of the SBHCI and the database is built through entries by voluntary contribution of active members of the society on PCI procedures. The analysis was approved by the Research Ethics Committee, opinion no. 3.003.202 (CAEE: 00771112.9.0000.5483).

Data were grouped into three periods. The first period (2006-2008) included 8,205 patients, the second period (2009-2011), 8,264 patients, and the third period (2012-2016), 6,118 patients.

The clinical definition of acute myocardial infarction (MI) was the presence of abnormal cardiac biomarkers (CB), along with evidence of acute myocardial ischemia. The MI considered was type 1, characterized by atherothrombotic CAD and, generally triggered by rupture of an atherosclerotic plaque (rupture or erosion) with an increase in CB and one of the following findings: symptoms of acute myocardial ischemia, electrocardiogram (EKG) with new signs of ischemia, development of pathological Q waves, imaging tests with new loss of viable myocardium or new regional movement abnormality of the left ventricle wall, or identification of coronary thrombi on angiogram.[5]

Silent ischemia was defined as objective documentation of ischemia in the absence of angina or angina equivalent.

Cardiac-related death, MI or emergency coronary artery bypass graft (CABG) were considered MACE.

Thrombolysis in Myocardial Infarction (TIMI) grade flow was the classification used to assess post-thrombolysis coronary perfusion; grade zero is absence of anterograde flow after the point of occlusion; grade 1, to the passage of contrast by the point of obstruction without filling the entire bed distal to the obstruction; grade 2, to the passage of contrast through the obstruction and filling of the entire distal bed with rate of filling and/or emptying of the contrast distal to the lesion slower than that of the other arteries; and grade 3, to the presence of anterograde flow with emptying of contrast in the bed distal to the obstruction, similar to other arteries.[6]

The severity classification for patients with MI, proposed by Thomas Killip III and John T. Kimball, was: Killip I, if absence of signs of heart failure; Killip II, if presence of crackles or rails in lungs, S3 gallop and elevated jugular venous pressure; Killip III, if acute pulmonary edema; and Killip IV, if cardiogenic shock or hypotension (systolic blood pressure – SBP <90mmHg) and evidence of peripheral vasoconstriction (oliguria, cyanosis or diaphoresis), with mortality of 6%, 17%, 38% and 81%, respectively.[7]

Continuous variables were presented as means and standard deviations. Analysis of variance (ANOVA) was used to compare continuous variables of the periods from 2006 to 2016, and, the Bonferroni correction was used for multiple comparisons. Categorical variables were presented in absolute numbers and percentages. The Chi-square test was used to compare categorical variables in the period from 2006 to 2016, and the likelihood-ratio test was used whenever required. The patient was considered the sample unit for analysis of variables. Some patients underwent more than one procedure. In these cases, the procedure considered was selected randomly.

The influence of the variables of interest on mortality was analyzed by simple and multiple logistic regression models. Significance was set at 5% (p-value <0.05) for all analyses.

Oracle 10g software was used, and statistical analysis was performed on the Statistical Package for Social Science (SPSS), version 23.

RESULTS

Patients' mean age was 60.9±12.1 years, and 70.3% were men. Regarding clinical characteristics, 75.4% of patients had high blood pressure; 54.3% had dyslipidemia; 20.5% diabetes and 35.4% were smokers. In the most recent periods, there was a significant decrease in smokers when compared to the 2006-2008 period. In contrast, the number of patients with diabetes increased significantly in the most recent period (Table 1).

We observed that 14.8% of patients had a previous MI, 13.4% had already been submitted to PCI and 4.3% to coronary artery bypass surgery (CABG). Previous MI was significantly less frequent during 2012-2016 when compared to the 2006-2008 and 2009-2011 periods. In 2012- 2016, the proportion of patients with previous PCI was significantly higher than in the initial periods. Otherwise, during the same period, there was a significant decrease in the number of patients who had already been submitted to CABG.

There were 22,978 procedures performed, with a mean of 1.02 procedure per patient. There were 25,107 vessels treated, 23,237 (92.5%) of which with stents, totaling up 24,864 stents. Regarding the clinical presentation, during 2006-2008 the proportion of patients with stable angina and MI was significantly higher than in the other periods. During 2012-2016, the proportion of acute coronary syndrome (ACS) was significantly higher than in the previous periods. In the initial two periods, the proportion of Killip II was significantly higher than during 2012-2016, in which there was a higher incidence of Killip I.

Angiographic characteristics are presented in table 2. Single-vessel CAD prevailed (52.9%) and was significantly higher in the two most recent periods. Regarding vessels treated, there was a predominance of the left anterior descending artery (LAD) (43.7%). During 2012-2016, the intervention in LAD and left circumflex (LCx) was significantly higher than in the other periods. During 2006-2008, intervention in vascular grafts was significantly higher than in the following periods.

A proportion of 26.5% of lesions were observed to be calcified. During 2009-2011, the proportion was significantly higher than during 2006-2008 and 2012-2016. During 2012-2016 the proportion was significantly lower than during 2006-2008. Long lesions (>20mm) totaled 33.8% and, during 2009-2011, they were significantly more frequent than in the 2006-2008 and 2012-2016 periods, with a significantly higher incidence of long lesions in the initial period in comparison to the most recent one. There

Table 1. Clinical characteristics

Characteristic	2006-2008 (n=8,205 patients)	2009-2011 (n=8,264 patients)	2012-2016 (n=6,118 patients)	Total (n=22,587 patients)	p-value
Age, years	60.8±12.1	61.0±12.2	61.0±12.2	60.9±12.1	0.297
Male sex	5,793 (70.6)	5,750 (69.6)	4,333 (70.8)	15,876 (70.3)	0.199
Smoking	3,255 (39.7)	2,876 (34.8)	1,862 (30.4)	7,993 (35.4)	<0.0001
Hypertension	6,165 (75.1)	6,261 (75.8)	4,574 (75.3)	17,000 (75.4)	0.549
Dyslipidemia	4,408 (53.7)	4,491 (54.8)	3,297 (54.5)	12,196 (54.3)	0.381
Diabetes	1,668 (20.3)	1,545 (19.7)	1,152 (21.9)	4,365 (20.5)	0.008
Previous MI	1,367 (16.7)	1,153 (14.7)	626 (11.9)	3,146 (14.8)	<0.0001
Previous PCI	957 (11.8)	871 (10.8)	1,144 (19.2)	2,972 (13.4)	<0.0001
Previous CABG	436 (5.3)	343 (4.2)	195 (3.2)	974 (4.3)	<0.0001
Clinical presentation					<0.0001
Stable angina	906 (11.0)	636 (7.7)	461 (7.5)	2,003 (8.9)	
Silent ischemia	149 (1.8)	337 (4.1)	282 (4.6)	768 (3.4)	
STEMI	5,580 (68.0)	5,354 (64.8)	3,756 (61.4)	14,690 (65.0)	
NSTEMI	1,570 (19.1)	1,937 (23.4)	1,619 (26.5)	5,126 (22.7)	
Killip					<0.0001
I	4,110 (73.7)	4,001 (74.8)	2,905 (78.1)	11,016 (75.2)	
II	896 (16.1)	828 (15.5)	461 (12.4)	2,185 (14.9)	
III	251 (4.5)	193 (3.6)	144 (3.9)	588 (4.0)	
IV	317 (5.7)	326 (6.1)	210 (5.6)	853 (5.8)	

Results expressed as mean ± standard deviation or n (%). MI: myocardial infarction; PCI: percutaneous coronary intervention; CABG: coronary artery bypass surgery; STEMI: ST-segment elevation myocardial infarction; NSTEMI: non-ST segment elevation acute coronary syndrome.

Table 2. Angiographic characteristics

Characteristic	2006-2008 (n=8,326 procedures/ n=9,058 vessels)	2009-2011 (n=8,447 procedures/ n=9,195 vessels)	2012-2016 (n=6,205 procedures/ n=6,854 vessels)	(n=22,978 procedures/ n=25,107 vessels)	p-value
Extension of coronary artery disease					<0.0001
Single vessel	4,160 (51.0)	4,455 (54.0)	3,211 (54.1)	11,826 (52.9)	
Two-vessel	2,382 (29.2)	2,293 (27.8)	1,716 (28.9)	6,391 (28.6)	
Three-vessel	1,581 (19.4)	1,491 (18.1)	1,001 (16.9)	4,073 (18.2)	
LMCA	38 (0.5)	8 (0.1)	4 (0.1)	50 (0.2)	
Treated vessels					<0.0001
RCA	3,343 (36.9)	3,492 (38.0)	2,534 (37.0)	9,369 (37.3)	
LCx	1,430 (15.8)	1,377 (15.0)	1,111 (16.2)	3,918 (15.6)	
LAD	3,919 (43.3)	4,021 (43.7)	3,027 (44.2)	10,967 (43.7)	
Saphenous vein graft	321 (3.5)	243 (2.6)	141 (2.1)	705 (2.8)	
LMCA	45 (0.5)	62 (0.7)	41 (0.6)	148 (0.6)	
Type B_2/C lesions	7,522 (90.0)	391 (92.2)	117 (92.9)	8,030 (90.2)	0.203
Calcified lesions	2,395 (26.4)	2,606 (28.5)	1,550 (23.8)	6,551 (26.5)	<0.0001
Long lesions (>20 mm)	3,114 (34.4)	3,298 (35.9)	2,067 (30.2)	8,479 (33.8)	<0.0001
Bifurcations	2,960 (32.7)	3,103 (33.7)	1,996 (29.1)	8,059 (32.1)	<0.0001
Total occlusions	5,236 (58.1)	5,268 (57.3)	3,987 (58.2)	14,491 (57.8)	0.4623
TIMI flow pre					<0.0001
0/1	5,736 (63.3)	5,960 (64.8)	4,111 (60.0)	15,807 (63.0)	
2/3	3,322 (36.7)	3,235 (35.2)	2,743 (40.0)	9,300 (37.0)	
Left ventricular dysfunction	4,939 (78.5)	4,109 (80.2)	3,067 (78.5)	12,115 (79.1)	0.0549
Collateral circulation	2,397 (29.3)	1,495 (29.6)	817 (20.3)	4,709 (27.3)	<0.0001

Results expressed as n (%). LMCA: left main coronary artery; RCA: right coronary artery; LCx: circumflex; LDA: left anterior descending artery; TIMI: Thrombolysis in Myocardial Infarction.

were 32.1% of vessels with bifurcation lesions, and during the 2006-2008 and 2009-2011 periods the proportion was significantly higher than during 2012-2016.

Over half of patients (63%) were classified as having TIMI grade flow 0/1, with a significantly higher proportion during 2009-2011, followed by 2006-2008 and, then by 2012-2016. Moreover, 27.3% of angiograms showed collateral circulation, and with a significantly higher relevance during 2006-2008 and 2009-2011, than during 2012-2016.

Table 3 presents the characteristics of procedures performed. During 2012-2016, the mean treated vessels/patient ratio was higher than during 2006-2008. During 2009-2011 and 2012-2016, the proportion of patients with stent and the stent/patient ratio were significantly higher than during 2006-2008. Inversely, during 2006-2008 and 2009-2011, the mean diameter of stents was significantly larger than during 2012-2016. However, during 2012-2016, the mean length of stents was significantly longer than in the other periods; in that, during 2009-2011, there was also a significant increase in comparison to 2006-2008. Drug-eluting stents were used in 9.1% of procedures. During 2012-2016 the proportion of drug-eluting stents was significantly higher than in the initial periods, and during 2009-2011 it was significantly higher than during 2006-2008.

Regarding types of interventions, 46.4% were primary PCI and 2.9% were rescue PCI. During 2009-2011, the proportion of primary PCI stents was significantly higher than in other periods, and during 2006-2008 the proportion of rescue PCI stents was significantly higher than in the other periods.

The use of glycoprotein (GP) IIb/IIIa inhibitors (15.3%) decreased with time, that is, during 2012-2016 there was a significant fall in comparison with previous periods. In contrast, thrombus-aspiration (4.3%) grew significantly during 2012-2016 when compared to previous periods. The post-procedure TIMI grade flow 2/3 was 95.7%, while the 0/1 was 4.3%, and during 2012-2016 the proportion of post-procedure TIMI grade flow 0/1 was significantly lower than in previous periods. The level of success of the procedure increased significantly with time.

Table 4 shows clinical outcomes during the hospital phase. Acute myocardial infarction (0.5%), death (2.6%) and MACE (2.9%) were significantly higher during 2006-2008 than in the other periods.

Table 5 presents the variables associated with mortality. Influencing factors were patients during 2006-2008; older age; female sex; non-smoker; no dyslipidemia; presence of diabetes; previous AMI; previous CABG; Killip IV (vs. Killip I, II and III); two-vessel extent (vs. one-vessel); three-vessel extent (vs. one-vessel); lesion extending to left main coronary artery (LMCA) (vs. one-vessel); presence of left ventricle dysfunction; primary PCI and use of GP IIb/IIIa inhibitors.

In the multiple logistic regression (Table 6), the initial period of treatment, older age, female sex, absence of dyslipidemia, presence of diabetes, previous MI, longer extent of CAD, use of GP IIb/IIIa inhibitors, and primary intervention were risk factors that better explained mortality.

DISCUSSION

The objective of the study was to analyze data from CENIC in order to compare clinical, angiographic and procedural characteristics, and clinical outcomes during the in-hospital phase of PCI patients with atherothrombotic lesions. Age is one of the strongest indicators for mortality after PCI. Elderly patients have a clinical risk profile substantially higher, albeit angiographic success rates and clinical benefits of PCI are similar to younger individuals.[5] Despite higher incidence in men, women present higher risk of mortality when compared to men. However, female sex has been shown not to be an independent predictor of mortality. High mortality among women occurs mainly due

Table 3. Characteristics of procedures

Characteristic	2006-2008 (n=8,205 patients/ n=8,326 procedures/ n=8,795 stents)	2009-2011 (n=8,264 patients/ n=8,447 procedures / n=9,153 stents)	2012-2016 (n=6,118 patients/ n=6,205 procedures / n=6,916 stents)	Total (n=22,587 patients/ n=22,978 procedures / n=24,864 stents)	p-value
Treated vessels/patient	1.1±0.3	1.1±0.4	1.1±0.4	1.1±0.4	0.026
Use of stent	7,520 (91.7)	7,660 (92.7)	5,701 (93.2)	20,881 (92.4)	0.002
Stent/patient ratio	1.2±0.4	1.2±0.5	1.2±0.5	1.2±0.5	<0.0001
Drug-eluting stents	459 (5.2)	726 (7.9)	1,070 (15.5)	2,255 (9.1)	<0.0001
Stent diameter, mm	3.15±0.47	3.14±0.48	3.09±0.5	3.13±0.48	<0.0001
Stent length, mm	20.2±6.3	20.6±6.9	21.3±7.9	20.7±7	<0.0001
Types of intervention					<0.0001
Primary PCI	3,860 (46.4)	4,065 (48.1)	2,728 (44.0)	10,653 (46.4)	
Rescue PCI	472 (5.7)	115 (1.4)	89 (1.4)	676 (2.9)	
Glycoprotein IIb/IIIa inhibitors	1,783 (21.4)	1,160 (13.7)	584 (9.4)	3,527 (15.3)	<0.0001
Thromboaspiration	109 (1.2)	461 (5.0)	495 (7.2)	1,065 (4.3)	<0.0001
TIMI flow post					<0.0001
0/1	513 (5.8)	395 (4.3)	165 (2.4)	1,073 (4.3)	
2/3	8,267 (94.2)	8,750 (95.7)	6,748 (97.6)	23,765 (95.7)	
Stenosis grade					
Pre	95.5 (8.9)	95.5 (9.3)	96.2 (15.8)	95.7 (11.4)	0.0002
Post	3.0 (12.0)	3.1 (10.4)	5.5 (5.5)	3.7 (10)	<0.0001
Success of procedure	7,648 (91.9)	7,973 (94.4)	5,929 (95.6)	21,550 (93.8)	<0.0001

Results expressed as mean ± standard deviation, or n (%). PCI: percutaneous coronary intervention; TIMI: Thrombolysis in Myocardial Infarction.

Table 4. In-hospital clinical outcomes

Outcome	2006-2008 (n=8,205 patients)	2009-2011 (n=8,264 patients)	2012-2016 (n=6,118 patients)	Total (n=22,587 patients)	p-value
MI	65 (0.8)	34 (0.4)	17 (0.3)	116 (0.5)	0.0004
Emergency CABG	0	13 (0.17)	2 (0.04)	15 (0.11)	0.059
Death	258 (3.1)	177 (2.3)	129 (2.3)	564 (2.6)	0.0005
MACE	309 (3.8)	213 (2.6)	141 (2.3)	663 (2.9)	<0.0001

Results expressed as n (%). MI: myocardial infarction; CABG: coronary artery bypass surgery; MACE: major adverse cardiovascular events.

Table 5. Simple logistic regression

	Estimate	p-value	OR	95%CI
2009-2011 vs. 2006-2008	-0.34	0.0006	0.71	0.59-0.86
2012-2016 vs. 2006-2008	-0.32	0.004	0.73	0.59-0.9
Age, years	0.05	<0.0001	1.05	1.04-1.06
Sex, female vs. male	0.49	<0.0001	1.63	1.38-1.94
Smoking, no vs. yes	0.41	<0.0001	1.50	1.25-1.81
Hypertension, yes vs. no	0.02	0.837	1.02	0.84-1.24
Dyslipidemia, no vs. yes	0.19	0.028	1.21	1.02-1.43
Diabetes, yes vs. no	0.54	<0.0001	1.71	1.42-2.06
Prior MI, yes vs. no	0.34	0.002	1.40	1.13-1.75
Prior PCI, yes vs. no	0.08	0.508	1.09	0.85-1.38
Prior CABG, yes vs. no	0.51	0.003	1.66	1.19-2.31
Clinical picture, angina vs. AMI	-2.02	<0.0001	0.13	0.07-0.26
Clinical picture, silent ischemia vs. MI	-1.11	0.007	0.33	0.15-0.74
Clinical presentation, ACS vs. MI	-0.98	<0.0001	0.38	0.29-0.49
Killip, I vs. IV	-3.82	<0.0001	0.02	0.02-0.03
Killip, II vs. IV	-2.59	<0.0001	0.07	0.06-0.1
Killip, III vs. IV	-1.34	<0.0001	0.26	0.19-0.36
Extension of CAD, two-vessel vs. single-vessel	0.75	<0.0001	2.12	1.69-2.65
Extension of CAD, three-vessel vs. single-vessel	1.52	<0.0001	4.59	3.72-5.67
Extension of CAD, LMCA vs. single-vessel	3.27	<0.0001	26.42	13.75-50.74
Left ventricular dysfunction, yes vs. no	1.50	<0.0001	4.48	2.74-7.32
Collateral circulation, yes vs. no	0.05	0.633	1.05	0.86-1.29
Types of intervention, primary vs. others	1.39	<0.0001	4.01	3.25-4.95
Types of intervention, rescue vs. others	1.54	<0.0001	4.69	3.12-7.04
Glycoprotein IIb/IIIa inhibitors, yes vs. no	0.44	<0.0001	1.56	1.28-1.91

MI: myocardial infarction; PCI: percutaneous coronary intervention; CABG: coronary artery bypass grafting; ACS: acute coronary syndrome; CAD: coronary artery disease; LMCA: left main coronary artery.

Table 6. Multiple logistic regression

	Estimate	p-value	OR	95%CI
Constant	-7.98	<0.0001		
2009-2011 vs. 2006-2008	-0.30	0.004	0.74	0.6-0.91
2012-2016 vs. 2006-2008	-0.39	0.002	0.68	0.53-0.87
Age, years	0.04	<0.0001	1.04	1.03-1.05
Sex, female vs. male	0.28	0.004	1.32	1.09-1.6
Dyslipidemia, no vs. yes	0.24	0.009	1.28	1.06-1.53
Diabetes, yes vs. no	0.34	0.0009	1.41	1.15-1.72
Prior MI, yes vs. no	0.64	<0.0001	1.90	1.5-2.41
Extension of CAD, two-vessel vs. single-vessel	0.63	<0.0001	1.88	1.48-2.39
Extension of CAD, three-vessel vs. single-vessel	1.21	<0.0001	3.35	2.66-4.22
Extension of CAD, LMCA vs. single-vessel	3.03	<0.0001	20.78	9.69-44.53
Glycoprotein IIb/IIIa inhibitors, yes vs. no	0.23	0.040	1.26	1.01-1.57
Types of intervention, primary vs. others	1.44	<0.0001	4.22	3.32-5.36
Types of intervention, rescue vs. others	1.71	<0.0001	5.51	3.56-8.55

MI: myocardial infarction; CAD: coronary artery disease; LMCA: left main coronary artery.

to greater clinical severity, more advanced age and longer delay to treatment in this group.[8,9]

The analysis revealed a higher likelihood of death in patients with diabetes. The prevalence of cardiovascular disease mortality among diabetic patients is four-fold higher than among non-diabetic individuals. The metabolic changes that occur in diabetes compromise the endothelial function and predispose to atherosclerotic vascular lesions, vasospasm and thrombosis.[10]

There has been a significant decrease in smoking during the years studied, but paradoxically, smoking was associated with a "protective effect": smokers had lower

mortality rates. However, the TRACE (TRAndolapril Cardiac Evaluation), OPTIMAAL (Optimal Trial In Myocardial Infarction with the Angiotensin Antagonist Losartan) and GRACE (Global Registry of Acute Coronary Events) studies, after adjusted analysis, showed robust evidence arguing against protection of smoking and showing that such paradoxical effect does not exist. The highest mortality risk is due to other clinical, angiographic and procedural factors.[11]

Analyzing periods, CABG and PCI incidences decreased and increased, respectively. Technological progress and scientific research in interventional cardiology have grown exponentially. The SYNTAX (Synergy Between PCI with Taxus and Cardiac Surgery) study compared PCI vs. CABG in complex multi-vessel patients with and without LMCA lesions, and enabled quantifying angiographic complexity, by considering the number and location of lesions, in addition to morphologic analysis of each stenosis, which allowed stratifying patients to select the best procedure. The improvement with SYNTAX II, which combined angiographic and clinical factors, is that it proved to be a discerning tool and indicator of mortality in the late follow-up of the SYNTAX study.[12,13]

There was a significant increase in bare-metal and drug-eluting stents use. Moreover, the progress in new generation drug-eluting stents, with new metal alloys (for example, chrome-cobalt and platinum-chrome), platforms with thinner struts with more biocompatible polymers, and 100% bioabsorbable polymers, have shown superiority in comparison to the first generation drug-eluting stents, both in efficacy and safety, with a striking reduction in long-term occurrence of MACE, even with short-term dual antiplatelet therapy (DAPT) (30 days).[14]

A reduction in the use of GP IIb/IIIa inhibitors was observed between periods due to new antiplatelet agents in combination with current anti-thrombotic therapy, as the routine use did not prove beneficial and may lead to higher rates of severe bleeding. Use occurred in specific scenarios, such as high thrombotic burden, slow/no reflow phenomenon, coronary dissections or other thrombotic complications. The highest mortality occurred in the group using GP IIb/IIIa inhibitors due to higher clinical severity, anatomical complexity and worse hospital course.[15]

In STEMI, thrombus aspiration became relevant in the TAPAS study, which demonstrated that manual aspiration of thrombi, before primary PCI, enabled better myocardial blush, better ST-segment resolution and reduction in one-year mortality, although not in 30 days.[16] However, the TASTE and TOTAL studies, considering the same scenario mentioned, did not show reduction in mortality, and an increase in the risk of cerebrovascular accident was observed. Currently the procedure has remained restricted to interventions in the presence of high thrombus burden and bailout.[17,18]

The reduction in MI, in addition to decrease in MACE and decrease in mortality among the years observed, occurred due to higher use of reperfusion therapy, primary PCI, new materials, modern antithrombotic therapy and secondary prevention.[8,19]

CONCLUSION

The analysis of the CENIC database showed that there are variables that influence mortality in percutaneous coronary interventions on thrombus-containing lesions. In the initial period, more deaths, and a higher incidence of patients with acute myocardial infarction, stable angina and previous CABG were observed. Clinical findings that better explained mortality were elderly patients, female sex, and absence of dyslipidemia and presence of diabetes. Patients with more coronary artery disease had higher mortality. The higher number of deaths occurred in primary percutaneous coronary intervention procedures and with the use of glycoprotein IIb/IIIa inhibitors due to higher clinical severity and anatomic complexity. An exponential growth in technological advances and scientific research in interventional cardiology was observed in these periods.

SOURCE OF FINANCING

None.

CONFLICTS OF INTEREST

The authors declare there are no conflicts of interest.

CONTRIBUTION OF AUTHORS

Conception and design of the study: RSA, RSAF; data collection: RSA, MAP, VPRJ, CFS, LCM; data interpretation: RSA, PAB, JFFJ, ANP; text writing: RSA, MAU; approval of the final version to be published: RSA, CG, JLAS.

REFERENCES

1. Organização Pan-Americana da Saúde (OPAS) Brasil. 10 principais causas de morte no mundo [Internet]. Brasília, DF: OPAS; 2018 [cited 2019 Apr 23]. Available from: https://www.paho.org/bra/index.php?option=com_content&view=article&id=5638:10-principais-causas-de-morte-no-mundo&Itemid=0
2. Cesar LA, Ferreira JF, Armaganijan D, Gowdak LH, Mansur AP, Bodanese LC, et al. Diretriz de Doença Coronária Estável. Arq Bras Cardiol. 2014;103(2Supl.2):1-59.
3. Kerensky RA, Wade M, Deedwania P, Boden WE, Pepine CJ; Veterans Affairs Non QWISi-HTI. Revisiting the culprit lesion in non-Q-wave myocardial infarction. Results from the VANQWISH trial angiographic core laboratory. J Am Coll Cardiol. 2002;39(9):1456-63.
4. Henriques JP, Zijlstra F, Ottervanger JP, de Boer MJ, van't Hof AW, Hoorntje JC, et al. Incidence and clinical significance of distal embolization during primary angioplasty for acute myocardial infarction. Eur Heart J. 2002;23(14):1112-7.
5. Thygesen K, Alpert JS, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA, White HD; ESC Scientific Document Group. Fourth universal definition of myocardial infarction. Eur Heart J. 2019;40(3):237-69.

6. TIMI Study Group. The Thrombolysis in Myocardial Infarction (TIMI) trial. Phase I findings. N Engl J Med. 1985;312(14): 932-6.
7. Mello BH, Oliveira GB, Ramos RF, Lopes BB, Barros CB, Carvalho Ede O, Teixeira FB, Arruda GD, Revelo MS, Piegas LS. Validation of the Killip-Kimball classification and late mortality after acute myocardial infarction. Arq Bras Cardiol. 2014;103(2):107-17.
8. Levine GN, Bates ER, Blankenship JC, Bailey SR, Bittl JA, Cercek B, et al. 2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines and the Society for Cardiovascular Angiography and Interventions. Circulation. 2011;124(23):e574-e651. Erratum in: Circulation. 2012;125(8):e412. Dosage error in article text.
9. Barbosa RR, Silva VR, Serpa RG, Cesar FB, Mauro VF, Bayerl DM, et al. Diferenças de gênero nos resultados da intervenção coronariana percutânea primária em pacientes com infarto do miocárdio com elevação de ST. Rev Bras Cardiol Invasiva. 2015;23(2):96-101.
10. Lopes MA, Barros MA, Oliveira IR, Martins HC, Paiva MS, Lima JA, et al. Comparação do perfil epidemiológico, clínico e dos resultados das intervenções coronárias percutâneas entre os gêneros masculino e feminino, na população brasileira: Dados do Registro CENIC. Rev Bras Cardiol Invas. 2008;16(4):463-73.
11. Sposito AC, Caramelli B, Fonseca FA, Bertolami MC. IV Diretriz Brasileira Sobre Dislipidemias e Prevenção da Aterosclerose. Arq Bras Cardiol. 2007;88(Suppl.1):2-19.
12. Curado FA, Carvalho G, Bastos Filho AT, Custodio WB, Brito WA, Cantarelli M. Intervenção coronária percutânea primária ou de resgate em tabagistas. Rev Bras Cardiol Invasiva. 2016;24:19-24.
13. Souza MT, Pereira AH, Barbosa, Caixeta A. Intervenção percutânea e revascularização miocárdica no paciente com DM – elementos que devem ser considerados. Rev Soc Cardiol Estado de São Paulo. 2018;28(2):176-80.
14. Gomes WJ, Braile DM. Estudo SYNTAX: análise e implicações clínicas. Rev Bras Cir Cardiovasc. 2018;23(4):III-V.
15. Alves RC, Mota FB, Cantarelli FL, Moreira MN, Falcão FJ, Baião AH, et al. Use of platelet glycoprotein IIb/IIIa inhibitors in primary percutaneous coronary intervention: 10-year experience in Brazil. J Transcat Intervent. 2018;26(2):1-6.
16. Vlaar PJ, Svilaas T, van der Horst IC, Diercks GF, Fokkema ML, de Smet BJ, et al. Cardiac death and reinfarction after 1 year in the Thrombus Aspiration during Percutaneous coronary intervention in Acute myocardial infarction Study (TAPAS): a 1-year follow-up study. Lancet. 2008;371(9628):1915-20.
17. Fröbert O, Lagerqvist B, Olivecrona GK, Omerovic E, Gudnason T, Maeng M, Aasa M, Angerås O, Calais F, Danielewicz M, Erlinge D, Hellsten L, Jensen U, Johansson AC, Kåregren A, Nilsson J, Robertson L, Sandhall L, Sjögren I, Ostlund O, Harnek J, James SK; TASTE Trial. Thrombus Aspiration during ST-Segment Elevation Myocardial Infarction. N Engl J Med. 2013;369(17):1587-97. Erratum in: N Engl J Med. 2014;371(8):786.
18. Jolly SS, Cairns JA, Yusuf S, Meeks B, Pogue J, Rokoss MJ, Kedev S, Thabane L, Stankovic G, Moreno R, Gershlick A, Chowdhary S, Lavi S, Niemelä K, Steg PG, Bernat I, Xu Y, Cantor WJ, Overgaard CB, Naber CK, Cheema AN, Welsh RC, Bertrand OF, Avezum A, Bhindi R, Pancholy S, Rao SV, Natarajan MK, ten Berg JM, Shestakovska O, Gao P, Widimsky P, Džavík V; TOTAL Investigators. Randomized Trial of Primary PCI with or without Routine Manual Thrombectomy. N Engl J Med. 2015;372(15):1389-98.
19. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, Caforio ALP, Crea F, Goudevenos JA, Halvorsen S, Hindricks G, Kastrati A, Lenzen MJ, Prescott E, Roffi M, Valgimigli M, Varenhorst C, Vranckx P, Widimský P; ESC Scientific Document Group. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J. 2018;39(2):119-77.