Clinical, angiographic profile and predictors of in-hospital mortality in percutaneous treatment of lesions in saphenous vein grafts

Perfil clínico, angiográfico e preditores de mortalidade hospitalar no tratamento percutâneo de lesões em enxertos venosos

Bruno Henrique Gallindo de Mello¹, Marinella Centemero¹

¹ Instituto Dante Pazzanese de Cardiologia, São Paulo, SP, Brazil.

DOI: 10.31160/JOTCI2018;26(1)A0016

ABSTRACT – Background: The angiographic characteristics associated with saphenous vein graft degeneration and the high-risk profile of these patients increase the probability of adverse outcomes during and after percutaneous coronary intervention. This study set out to analyze the clinical and angiographic profile of patients, procedural characteristics, and hospital outcomes of percutaneous coronary intervention performed in saphenous vein grafts, and to investigate predictors of in-hospital mortality in this group. **Methods:** A retrospective, observational study based on records kept by *Central Nacional de Intervenções Cardiovasculares* (CENIC) between 2006 and 2016. A comparative analysis of the adverse outcomes – periprocedural acute myocardial infarction, need for urgent coronary artery bypass grafting, and all-cause mortality – was performed according to different time periods (2006-2008, 2009-2011 and 2012-2016). **Results:** A total of 2,361 patients were included in the analysis. The prevalence of periprocedural acute myocardial infarction and mortality did not differ between time periods. No patient in this sample required urgent coronary artery bypass grafting. Simple logistic regression analysis revealed the following in-hospital mortality predictors: advanced age, ST-segment elevation acute myocardial infarction, Killip class 3/4, long lesions, thrombi-containing lesions, three-vessel disease and periprocedural acute myocardial infarction. According to multiple logistic regression analysis, age (OR 1.07; 95%CI 1.02-1.13; p=0.01), smoking (OR 3.26; 95%CI 1.13 – 9.39; p=0.03), ST-segment elevation acute myocardial infarction (OR 10.36; 95%CI 3.96-27.07; p<0.01) and periprocedural acute myocardial infarction (OR 86.08; 95%CI 15.81-468.63; p<0.01) were correlated with mortality outcomes. **Conclusion:** Identification of in-hospital mortality predictors may contribute to improve procedural planning for adverse events prevention in patients undergoing percutaneous coronary intervention of saphenous vein grafts.

Keywords: Percutaneous coronary intervention; Stents; Myocardial revascularization; Mortality; Saphenous vein.

RESUMO – Introdução: As características angiográficas relacionadas ao processo degenerativo dos enxertos de veia safena e o perfil de alto risco destes pacientes aumentam a probabilidade de desfechos adversos durante e após a intervenção coronária percutânea. O objetivo deste estudo foi analisar o perfil clínico e angiográfico, as características dos procedimentos, e os resultados hospitalares das intervenções coronárias percutâneas realizadas em enxertos de veia safena, além de verificar preditores de mortalidade hospitalar neste grupo. **Métodos:** Estudo retrospectivo, observacional, baseado nos cadastros da Central Nacional de Intervenções Cardiovasculares (CENIC), entre 2006 e 2016. Analisaram-se comparativamente os intervalos de anos (2006-2008, 2009-2011 e 2012-2016) e os desfechos infarto agudo do miocárdio periprocedimento, necessidade de revascularização miocárdica de urgência e óbito por todas as causas. **Resultados:** Foram analisados 2.361 pacientes. Não houve diferença na prevalência de infarto agudo do miocárdio periprocedimento e óbito nos três períodos. Nenhum paciente necessitou de cirurgia de revascularização miocárdica de urgência. Na regressão logística simples, os preditores de mortalidade hospitalar foram idade avançada, apresentação clínica de infarto agudo do miocárdio com supradesnivelamento do segmento ST, Killip 3/4, lesões longas e com trombos, triarteriais e ocorrência de infarto agudo do miocárdio periprocedimento. Na análise de regressão logística múltipla, idade (OR 1,07; IC95% 1,02-1,13; p=0,01), tabagismo (OR 3,26;

How to cite this article:

Mello BH, Centemero M. Clinical, angiographic profile and predictors of in-hospital mortality in percutaneous treatment of lesions in saphenous vein grafts. J Transcat Intervent. 2018;26(1):eA0016. [https://doi.org/10.31160/JOTCI2018;26\(1\)A0016](https://doi.org/10.31160/JOTCI2018;26(1)A0016)

Corresponding author:

Bruno Henrique Gallindo de Mello
Rua Bento de Andrade, 58 – Jardim Paulista
Zip code: 04503-000 – São Paulo, SP, Brazil
E-mail: brunohgm1@yahoo.com.br

Received on:

Jan 16, 2018

Accepted on:

Sept 18, 2018

This content is licensed under a Creative Commons Attribution 4.0 International License.

IC95% 1,13-9,39; $p=0,03$), infarto agudo do miocárdio com supradesnívelamento do segmento ST (OR 10,36; IC95% 3,96-27,07; $p<0,01$) e infarto agudo do miocárdio periprocedimento (OR 86,08; IC95% 15,81-468,63; $p<0,01$) exibiram correlação com o desfecho óbito. **Conclusão:** Em pacientes submetidos à intervenção coronária percutânea em enxertos de veia safena, a identificação dos preditores de mortalidade hospitalar pode contribuir para melhor planejamento do procedimento, com o intuito de prevenir a ocorrência de eventos adversos.

Descritores: Intervenção coronária percutânea; Stents; Revascularização miocárdica; Mortalidade; Veia safena.

INTRODUCTION

Saphenous vein grafts (SVG) are extensively used in coronary artery bypass grafting (CABG) procedures and, compared to arterial grafts, are associated with unfavorable outcomes due to graft patency issues, with occlusion of one or more anastomoses occurring in up to 41% of cases within one year of surgery.¹ Therefore, percutaneous coronary intervention (PCI) of SVG is common, accounting to 5 to 10% of all interventions performed in clinical practice.¹

Vein graft failure may be acute or late (within 30 days or beyond 1 year of CABG, respectively) and pathophysiologic features differ in each case.² While factors associated with surgery and preexisting anatomy, such as endothelial denudation during vein graft preparation, diffuse native coronary artery disease, competitive flow and anastomotic suture problems prevail in the acute phase, atherosclerotic degeneration, often diffuse, with friable plaques and high thrombotic load, is more common in the late phase.^{3,4} Due to these characteristics, PCI for treatment of late SVG failure is therefore more challenging. Distal embolization and slow-flow or no-reflow phenomena may occur in up to 10 to 15% of cases, with greater likelihood of periprocedural acute myocardial infarction (MI) and increased patient morbidity and mortality.^{5,6} PCI of SVG results in higher rates of restenosis, repeat CABG, acute MI or death, as compared to *de novo* coronary artery PCI, even when drug-eluting stents and more advanced technologies are used.¹ Hence, native coronary artery intervention is preferred (provided the vessel is patent), although not always feasible in these patients.

Repeat CABG has been associated with increased morbidity and mortality compared to primary procedures.⁷⁻¹⁰ However, robust comparative data of PCI and repeat CABG are lacking. Higher in-hospital mortality rates have been reported in patients undergoing repeat CABG as compared to graft PCI, despite similar long-term clinical outcomes and higher repeat CABG rates in PCI patients.^{11,12} These findings support the applicability of PCI in this subgroup of patients, particularly in the presence of patent internal mammary artery grafts and favorable anatomy.² Optimized

clinical treatment is also an alternative for selected cases, and should be the basis of any kind of invasive treatment.

This study set out to analyze the clinical and angiographic profile of revascularized patients, procedural characteristics and hospital outcomes of PCI performed in SVG, and to investigate predictors of in-hospital mortality in this group.

METHODS

A retrospective, observational multicenter study analyzing clinical, angiographic and procedural characteristics, and in-hospital outcomes of patients submitted to SVG PCI. The sample was obtained from *Central Nacional de Intervenções Cardiovasculares* (CENIC; <http://www.corehemo.net/>) database and included records entered between 2006 and 2016. CENIC data are spontaneously contributed by interventional cardiologists from different Brazilian hospitals and members of the *Sociedade Brasileira de Hemodinâmica e Cardiologia Intervencionista* (SBHCI).

All SVG PCI procedures recorded between June 2006 and March 2016 (divided into three time periods, as follows: 2006-2008, 2009-2011 and 2012-2016), were included. The following in-hospital clinical outcomes were analyzed: periprocedural acute MI, need for urgent CABG and all-cause mortality. The contribution of variables of interest to in-hospital mortality was also investigated. This study was submitted to and approved by the Research Ethics Committee of Hospital Bandeirantes S.A. (CAAE: 90669118.0.0000.5485).

Definitions

Periprocedural acute MI was defined as elevation of markers of myocardial necrosis by more than five times the upper limit of the reference range, or a minimum of 20% rise if previously altered, combined with symptoms suggestive of myocardial ischemia, new ischemic electrocardiogram changes, left branch bundle block, angiographic loss of coronary patency and/or flow, or imaging evidence of loss of viable myocardium, or changes in segmental myocardial contractility.¹³ Urgent CABG was defined as any repeat target lesion revascularization, occurring during the same hospitalization, due to ischemic signs and/or symptoms, and angiographic luminal diameter reduction $\geq 50\%$. Mortality was defined as death occurring during the same hospitalization, including cardiac or non-cardiac causes. Clinical and angiographic characteristics were defined according to current national guidelines.²

Statistical analysis

Categorical variables were expressed as frequency and percentage. Time periods between 2006 and 2016 were compared using the Chi-square test. The likelihood ratio test was as used as needed. Continuous variables were ex-

pressed as mean, standard deviation, median, minimum and maximum values. Time periods were compared using analysis of variance (ANOVA). Multiple comparisons were performed using the Bonferroni correction. Patients were the sampling unit in clinical variable analysis. For patients submitted to more than one procedure, the selection of procedure was made at random.

The contribution of variables of interest to mortality was investigated using simple and multiple regression models. The forward selection procedure was used to investigate the contribution of each independent variable to mortality in order to identify those that best explained the occurrence of death. Variables with large amounts of missing data, such as left ventricular dysfunction and presence of collateral circulation, were not considered. The level of significance was set at 5% ($p < 0.05$) for all analyses.

RESULTS

This study included 2,361 patients with previous CABG and submitted to PCI of SVG, listed in CENIC database, totaling up 2,464 procedures in 2,872 vessels, with stent implantation in all cases. The mean number of procedures per patient was 1.04. Mean patient age was 67.4 years; male patients prevailed and 33.4% were diabetic, with no significant differences between the three groups (Table 1). Overall, 14.4% of patients were smokers, with higher smoking prevalence in the 2006-2008 group. The percentage (44.1%)

of patients with a history of previous PCI was higher in the 2012-2016 compared to remaining periods (32.5% and 26%, 2009-2011 and 2006-2008, respectively; $p < 0.01$).

Clinical presentation also differed significantly. The percentage of patients with stable angina and ST-segment elevation myocardial infarction (STEMI) was higher between 2006 and 2008 compared to other time periods. Silent ischemia prevailed between 2012 and 2016, while non-ST-segment elevation acute coronary syndrome (NSTEMI) was more often diagnosed between 2009 and 2011. The percentage of STEMI patients with Killip class 3 or 4 was significantly higher between 2012 and 2016 compared to remaining time periods.

Among the angiographic characteristics displayed in table 2, the incidence of thrombotic lesions differed significantly between groups, with higher rates reported between 2006 and 2008. The prevalence of vessels with Thrombolysis in Myocardial Infarction (TIMI) grade flow 0 or 1 was higher in the 2006-2008 and 2012-2016, as compared to the 2009-2011 group.

Procedural data are shown in table 3. The use of drug-eluting stents increased significantly in more recent years, while the use of glycoprotein IIb/IIIa inhibitors dropped. Primary or rescue PCI were more common between 2006 and 2008 compared to remaining time periods. The use of thromboaspiration devices was limited to 1.3% of procedures and was more frequent between 2009 and 2011. Angiographic success was achieved in 96% of procedures, with no differences between groups.

Table 1. Clinical characteristics

Characteristics	2006-2008 (n=866 patients)	2009-2011 (n=875 patients)	2012-2016 (n=620 patients)	Total (n=2,361 patients)	p-value
Age, years	67.4±9.9	67.5±9.8	67.2±10.1	67.4±9.9	0.82
Male sex	612 (70.7)	628 (71.8)	443 (71.5)	1,683 (71.3)	0.87
Smoking	147 (17.0)	117 (13.4)	77 (12.4)	341 (14.4)	0.03
Hypertension	734 (84.8)	750 (85.7)	522 (84.2)	2,006 (85.0)	0.70
Dyslipidemia	612 (70.7)	627 (71.7)	424 (68.4)	1,663 (70.4)	0.39
Diabetes mellitus	275 (31.8)	296 (33.8)	218 (35.2)	789 (33.4)	0.37
Prior acute MI	290 (33.5)	277 (31.7)	179 (28.9)	746 (31.6)	0.17
Prior PCI	223 (26.0)	269 (32.5)	264 (44.1)	756 (33.1)	<0.01
Clinical presentation					<0.01
Stable angina	370 (42.7)	367 (41.9)	240 (38.7)	977 (41.4)	
Silent ischemia	51 (5.9)	81 (9.3)	81 (13.1)	213 (9.0)	
STEMI	103 (11.9)	63 (7.2)	54 (8.7)	220 (9.3)	
NSTEMI-ACS	342 (39.5)	364 (41.6)	245 (39.5)	951 (40.3)	
Killip					<0.01
1	72 (70.6)	41 (65.1)	35 (64.8)	148 (67.6)	
2	17 (16.7)	15 (23.8)	9 (16.7)	41 (18.7)	
3	7 (6.9)	3 (4.8)	5 (9.3)	15 (6.8)	
4	6 (5.9)	4 (6.3)	5 (9.3)	15 (6.8)	

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

Table 2. Angiographic characteristics

Characteristic	2006-2008 (n=907 procedures/ n=1,058 vessels)	2009-2011 (n=917 procedures/ n=1,075 vessels)	2012-2016 (n=640 procedures/ n=739 vessels)	Total (n=2,464 procedures/ n=2,872 vessels)	p-value
Disease extension					0.33
Three-vessel	536 (61.3)	561 (64.8)	397 (62.7)	1,494 (63.0)	
Others	338 (38.7)	305 (35.2)	236 (37.3)	879 (37.0)	
Type b2/c lesions	801 (83.5)	58 (85.3)	23 (92.0)	882 (83.8)	0.49
Calcified lesions	128 (12.1)	144 (13.4)	91 (12.3)	363 (12.6)	0.64
Thrombotic lesions	227 (21.5)	180 (16.7)	92 (12.4)	499 (17.4)	<0.01
Long lesions	263 (24.9)	266 (24.7)	154 (20.8)	683 (23.8)	0.09
Bifurcations	65 (6.1)	56 (5.2)	44 (6.0)	165 (5.7)	0.63
TIMI flow pre					<0.01
0/1	152 (14.4)	114 (10.6)	117 (15.8)	383 (13.3)	
2/3	906 (85.6)	961 (89.4)	622 (84.2)	2,489 (86.7)	
Left ventricular dysfunction	498 (70.1)	432 (72.1)	329 (73.9)	1,259 (71.8)	0.37
Collateral circulation	121 (14.0)	72 (12.8)	88 (17.7)	281 (14.6)	0.06

Results expressed as n (%). TIMI: Thrombolysis in Myocardial Infarction.

Table 3. Characteristics of procedures

Characteristic	2006-2008 (n=907 procedures/ n=1,079 stents)	2009-2011 (n=917 procedures/ n=1,105 stents)	2012-2016 (n=640 procedures/ n=747 stents)	Total (n=2,464 procedures/ n=2,931 stents)	p-value
Treated vessels/patient	1.2±0.5	1.2±0.6	1.2±0.5	1.2±0.5	0.35
Stent/patient ratio	1.3±0.6	1.3±0.6	1.3±0.6	1.3±0.6	0.81
Drug-eluting stents	179 (16.6)	251 (22.8)	211 (28.2)	641 (21.9)	<0.01
Stent length, mm	19.5±6.6	19.9±6.9	19.8±7.0	19.7±6.8	0.33
Types of intervention					0,01
Primary PCI	72 (7.9)	47 (5.1)	43 (6.7)	162 (6.6)	
Rescue PCI	7 (0.8)	1 (0.1)	1 (0.2)	9 (0.4)	
Glycoprotein IIb/IIIa inhibitors	114 (12.6)	61 (6.7)	16 (2.5)	191 (7.8)	<0.01
Thromboaspiration	7 (0.6)	27 (2.4)	5 (0.7)	39 (1.3)	<0.01
TIMI flow					0.10
0/1	33 (3.1)	21 (1.9)	13 (1.7)	67 (2.3)	
2/3	1,046 (96.9)	1,083 (98.1)	734 (98.3)	2,863 (97.7)	
Success of procedure	869 (95.8)	882 (96.2)	615 (96.1)	2,366 (96.0)	0.92

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

Considering in-hospital outcomes, periprocedural acute MI and mortality rates were low and did not differ between the three time periods investigated. Patients in this sample did not require urgent CABG (Table 4). The simple logistic regression model interrogated the contribution of each independent variable to mortality outcomes (Table 5). Patients treated between 2006 and 2008 had 3.74 higher chances of dying compared to those treated from 2009 to 2011 (OR 3.74, 95%CI 1.04-13.45; $p=0.043$). The risk of death also increased with age - 7% increase per additional year of life (OR 1.07; 95%CI 1.02-1.12; $p<0.01$). As regards clinical presentation, STEMI patients had higher risks of death compared to those with other clinical presentations (OR 11.27; 95%CI 4.73-26.86; $p<0.01$), as did those progressing to Killip 3 or 4 (OR 42.07; 95%CI 8.49-208.41;

$p<0.01$). Among angiographic characteristics, long lesions (OR 2.51; 95%CI 1.5-5.98; $p=0.04$), presence of thrombi (OR 2.98; 95%CI 1.23-7.25; $p=0.02$) and three-vessel disease (OR 5.32; 95%CI 1.23-22.99; $p=0.03$) were associated with higher mortality rates. Likewise, patients developing periprocedural acute MI (OR 21.5; 95%CI 5.82-79.47; $p<0.01$) had higher chances of dying during the hospitalization period.

The following in-hospital mortality predictors (Table 6) were identified in the multiple logistic regression analysis: age (OR 1.07; 95%CI 1.02-1.13; $p=0.01$), smoking (OR 3.26; 95%CI 1.13-9.39; $p=0.03$), STEMI (OR 10.36; 95%CI 3.96-27.07; $p<0.01$) and periprocedural acute MI (OR 86.08; 95%CI 15.81-468.63; $p<0.01$).

Table 4. In-hospital clinical outcomes

Outcome	2006-2008 (n=866 patients)	2009-2011 (n=875 patients)	2012-2016 (n=620 patients)	Total (n=2,361 patients)	p-value
Periprocedural acute MI	9 (1.0)	10 (1.1)	3 (0.5)	22 (0.9)	0.39
Emergency CABG	0	0	0	0	-
Death	11 (1.3)	3 (0.3)	6 (1.0)	20 (0.8)	0.10

Results expressed as n (%). MI: myocardial infarction; CABG: coronary artery bypass grafting.

Table 5. Influence of independent variables in death

Variable	p-value	OR	95%CI
2006-2008 vs. 2009-2011	0.04	3.74	1.04-13.45
2012-2016 vs. 2009-2011	0.14	2.84	0.71-11.40
Age, years	<0.01	1.07	1.02-1.12
Sex, female vs. male	0.11	2.04	0.84-4.96
Smoking, yes vs. no	0.19	1.99	0.72-5.51
HTN, no vs. yes	0.22	1.90	0.68-5.25
Dyslipidemia, no vs. yes	0.59	1.29	0.51-3.24
Diabetes mellitus, yes vs. no	0.88	1.07	0.43-2.70
Prior acute MI, yes vs. no	0.20	1.78	0.73-4.32
Previous PCI, no vs. yes	0.44	1.49	0.54-4.12
Clinical presentation, STEMI vs. others	<0.01	11.27	4.73-26.86
Killip, 3/4 vs. 1/2	<0.01	42.07	8.49-208.41
Extension of coronary disease, three-vessel vs. others	0.03	5.32	1.23-22.99
Left ventricular dysfunction, yes vs. no	0.19	4.00	0.51-31.33
Collateral circulation, yes vs. no	0.82	1.16	0.33-4.02
Glycoprotein IIb/IIIa inhibitors, no vs. yes	0.63	1.63	0.22-12.25
Long lesion, yes vs. no	0.04	2.51	1.05-5.98
Thrombotic lesion, yes vs. no	0.02	2.98	1.23-7.25
Acute MI after procedure, yes vs. no	<0.01	21.50	5.82-79.47

OR: odds ratio; 95%CI: 95% confidence interval; HTN: hypertension; MI: myocardial infarction; PCI: percutaneous coronary intervention; STEMI: ST-segment elevation myocardial infarction.

Table 6. In-hospital mortality predictors by multiple logistic regression analysis

Predictor	p-value	OR	95%CI
Age, years	0.01	1.07	1.02-1.13
Smoking, yes vs. no	0.03	3.26	1.13-9.39
Clinical presentation, STEMI vs. others	<0.01	10.36	3.96-27.07
Acute MI after procedure, yes vs. no	<0.01	86.08	15.81-468.63

OR: odds ratio; 95%CI: 95% confidence interval; STEMI: ST-segment elevation myocardial infarction; MI: myocardial infarction.

DISCUSSION

This study involved 2,361 patients submitted to PCI of SVG and revealed high procedural success and low in-hospital complication rates during the time periods considered.

Major in-hospital mortality predictors were age, smoking, STEMI and periprocedural acute MI. It also revealed a predominantly aged population comprising more than 30% of diabetic patients, most of whom suffered from triple vessel coronary disease and left ventricular dysfunction, manifested primarily as acute coronary syndrome. Complex angiographic lesions prevailed in the sample studied. These findings reflect the high-risk clinical profile of patients undergoing PCI of SVG.¹⁴

Compared to native vessel PCI, SVG interventions are associated with higher risks of adverse events in the short term, particularly periprocedural acute MI and related morbidity and mortality.^{5,6} This may reflect graft degeneration and ensuing atheromatous, thrombotic and friable lesions. SVG interventions were initially associated with 30-day mortality rates of 8%, compared to less than 1% mortality reported in contemporary studies.¹⁵ Overall mortality rate in this study was less than 1%, and urgent CABG was not required.

Higher risks of periprocedural acute MI are due to embolization of friable plaque fragments and ensuing microcirculatory obstructions, and can be reduced with the use of embolic protection devices.¹⁶⁻¹⁸ Elevation of biomarkers of myocardial necrosis has been associated with increased late mortality rates following PCI of SVG.^{5,15} Despite the low incidence of similar complications in this study, important correlations between periprocedural acute MI and in-hospital mortality were detected, emphasizing the relevance of preventing myocardial necrosis in susceptible populations. Limitations inherent to the data input method adopted in the database employed precluded the analysis of actual rates of embolic protection device use in the population studied.

Age was among the clinical variables with greater impact on in-hospital mortality, with each additional year of life accounting for a poorer prognosis. This finding is in keeping with previous reports of increased 30-day adverse outcome rates with age, in patients submitted to PCI of SVG.¹⁸ According to estimates of the American Heart Association (AHA), STEMI in-hospital mortality rates range from 5% to 6%.¹⁹ Patients with previous CABG presenting with STEMI are less prone to acute reperfusion, and tend to have less successful angiographic outcomes and higher 90-day mortality, as compared to patients without previous CABG, particularly when the culprit vessel is the vein graft.²⁰ Of those previously submitted to CABG, STEMI

patients undergoing PCI had higher chance of death than other clinical presentations in this sample.

Left ventricular dysfunction is thought to be predictor of in-hospital mortality in patients requiring PCI of SVG.²¹ In this study, left ventricular dysfunction was not associated with higher mortality rates. However, higher chance of death was documented in patients with acute heart failure Killip class 3 or 4, emphasizing the relevance of this classification method for risk stratification in acute coronary syndrome patients.²²

Women had a worse prognosis following native artery PCI compared to men. Different from this study, female sex was a predictor of 30-day in-hospital mortality in patients submitted to PCI of SVG in previous investigations.²¹ Diabetes mellitus did not increase the chance of in-hospital death in the population studied. A different correlation might have been found in the long term, as previously reported in several coronary disease scenarios, even in patients submitted to PCI of SVG.²¹ Smoking prevalence differed significantly between time periods in this study. This variable was associated with increased in-hospital mortality in this analysis, and was a predictor of 30-day cardiovascular outcomes in patients submitted to PCI of SVG in previous studies.¹⁸

Angiographic variables are also important predictors of adverse events in this population. Angiographic measurements of plaque volume, lesion length, presence of thrombi and graft degeneration scores are thought to be correlated with increased 30-day adverse outcome rates.^{15,18} In this sample, higher mortality rates were observed in patients presenting with lesions longer than 20mm, thrombotic lesions and three-vessel coronary disease. Despite the potent antiplatelet aggregation effect of glycoprotein IIb/IIIa inhibitors, studies investigating the use of these drugs in PCI of SVG failed to reveal protective benefits against adverse events, and suggested potentially harmful effects.²³⁻²⁵ Increased bleeding risks and the fact that such agents are oftentimes used in patients more likely to present adverse events may explain these findings. Routine use of these drugs in SVG treatment as a mean to prevent distal embolization is contraindicated.² Hence, the use of glycoprotein IIb/IIIa inhibitors was less common in more recent periods in this analysis and was not related to increased in-hospital mortality.

The rate of drug-eluting stent use in the population studied was low and increased significantly over time. This may have reflected limited availability of this technology in Brazilian public health system. Meta-analyses of major studies comparing the use of first generation drug-eluting stents and bare metal stents in PCI of SVG demonstrated superior beneficial effects on late clinical outcomes, with no differences in mortality.^{26,27} Robust, randomized studies are warranted to evaluate new generation drug-eluting stent outcomes in PCI of SVG.

Aside from the limited use of drug-eluting stents, and the lack of data on use of embolic protection devices and related impacts on outcomes, limitations inherent to the design of observational studies based on volunteered data input sources must be accounted for. Longer follow-up time of the population studied may have led to the identification of other long-term adverse event predictors. Comparative analysis was limited by significant differences between patient populations and procedures at different time periods in this study. These differences may have reflected changes in population characteristics or the improvement of interventional techniques over time. However, in-hospital outcome rates did not differ between the time periods studied.

CONCLUSION

Angiographic characteristics reflecting saphenous vein graft degeneration and the high-risk profile of these patients emphasize the challenging nature of percutaneous coronary intervention of saphenous vein grafts. Periprocedural acute myocardial infarction, urgent coronary artery bypass grafting and mortality rates did not differ between time periods in this observational study. Age, smoking, ST-segment elevation acute myocardial infarction and periprocedural acute myocardial infarction were the major in-hospital mortality predictors in the selected population.

Identification of these variables may contribute to the decision-making process regarding selection of strategies in patients previously submitted to coronary artery bypass grafting, as well as to improved percutaneous coronary intervention planning for prevention of in-hospital adverse cardiac events, with potential impacts on late clinical evolution.

FUNDING SOURCE

None.

CONFLICTS OF INTEREST

The authors have no conflicts of interest.

REFERENCES

1. Lee MS, Park SJ, Kandzari DE, Kirtane AJ, Fearon WF, Brilakis ES, et al. Saphenous vein graft intervention. *JACC Cardiovasc Interv.* 2011;4(8):831-43.
2. Feres F, Costa RA, Siqueira D, Costa Jr JR, Chamié D, Staico R, et al. Diretriz da Sociedade Brasileira de Cardiologia e da Sociedade Brasileira de Cardiologia Intervencionista sobre Intervenção Coronária Percutânea. *Arq Bras Cardiol.* 2017;109(1Supl.1):1-81.
3. Laflamme M, DeMey N, Bouchard D, Carrier M, Demers P, Pellerin M, et al. Management of early postoperative coronary artery bypass graft failure. *Interact Cardiovasc Thorac Surg.* 2012;14(4):452-6.

4. Kalan JM, Roberts WC. Morphologic findings in saphenous veins used as coronary arterial bypass conduits for longer than 1 year: necropsy analysis of 53 patients, 123 saphenous veins, and 1865 five-millimeter segments of veins. *Am Heart J*. 1990;119(5):1164-84.
5. Hong MK, Mehran R, Dangas G, Mintz GS, Lansky AJ, Pichard AD, et al. Creatine kinase-MB enzyme elevation following successful saphenous vein graft intervention is associated with late mortality. *Circulation*. 1999;100(24):2400-5.
6. Sdringola S, Assali AR, Ghani M, Moustapha A, Achour H, Yusuf SW, et al. Risk assessment of slow or no-reflow phenomenon in aortocoronary vein graft percutaneous intervention. *Catheter Cardiovasc Interv*. 2001;54(3):318-24.
7. Loop FD, Lytle BW, Cosgrove DM, Woods EL, Stewart RW, Golding LA, et al. Reoperation for coronary atherosclerosis. Changing practice in 2509 consecutive patients. *Ann Surg*. 1990; 212(3):378-86; discussion 385-6.
8. Edwards FH, Grover FL, Shroyer AL, Schwartz M, Bero J. The Society of Thoracic Surgeons national cardiac surgery database: current risk assessment. *Ann Thorac Surg*. 1997;63(3):903-8.
9. Grover FL, Johnson RR, Marshall G, Hammermeister KE. Factors predictive of operative mortality among coronary artery bypass subsets. *Ann Thorac Surg*. 1993;56(6):1296-307; discussion 1306-7.
10. Jones RH, Hannan EL, Hammermeister KE, DeLong ER, O'Connor GT, Luepker RV, et al. Identification of preoperative variables needed for risk adjustment of short-term mortality after coronary artery bypass graft surgery. *J Am Coll Cardiol*. 1996;28(6):1478-87.
11. Morrison DA, Sethi G, Sacks J, Henderson WG, Grover F, Sedlis S, Esposito R; Investigators of the Department of Veterans Affairs Cooperative Study #385, Angina With Extremely Serious Operative Mortality Evaluation. Percutaneous coronary intervention versus repeat bypass surgery for patients with medically refractory myocardial ischemia: AWESOME randomized trial and registry experience with post-CABG patients. *J Am Coll Cardiol*. 2002; 40(11):1951-4.
12. Harskamp RE, Beijk MA, Damman P, Kuijt WJ, Woudstra P, Grundeken MJ, et al. Clinical outcome after surgical or percutaneous revascularization in coronary bypass graft failure. *J Cardiovasc Med (Hagerstown)*. 2013;14(6):438-45.
13. Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, White HD; Writing Group on the Joint ESC/ACCF/AHA/WHF Task Force for the Universal Definition of Myocardial Infarction, Thygesen K, Alpert JS, White HD, Jaffe AS, Katus HA, Apple FS, Lindahl B, Morrow DA, Chaitman BA, Clemmensen PM, Johanson P, Hod H, Underwood R, Bax JJ, Bonow RO, Pinto F, Gibbons RJ, Fox KA, Atar D, Newby LK, Galvani M, Hamm CW, Uretsky BF, Steg PG, Wijns W, Bassand JP, Menasché P, Ravkilde J, Ohman EM, Antman EM, Wallentin LC, Armstrong PW, Simoons ML, Januzzi JL, Nieminen MS, Gheorghiade M, Filippatos G, Luepker RV, Fortmann SP, Rosamond WD, Levy D, Wood D, Smith SC, Hu D, Lopez-Sendon JL, Robertson RM, Weaver D, Tendera M, Bove AA, Parkhomenko AN, Vasilieva EJ, Mendis S; ESC Committee for Practice Guidelines (CPG). Third universal definition of myocardial infarction. *Eur Heart J*. 2012;33(20):2551-67.
14. Gruberg L, Hellkamp AS, Thomas LE, de Lemos JA, Scirica BM, Hilliard A, et al. The association of previous revascularization with in-hospital outcomes in acute myocardial infarction patients: results from the National Cardiovascular Data Registry. *JACC Cardiovasc Interv*. 2015;8(15):1954-62.
15. Kirtane AJ, Heyman ER, Metzger C, Breall JA, Carrozza JP. Correlates of adverse events during saphenous vein graft intervention with distal embolic protection: a PRIDE substudy. *JACC Cardiovasc Interv*. 2008;1(2):186-91.
16. Baim DS, Wahr D, George B, Leon MB, Greenberg J, Cutlip DE, Kaya U, Popma JJ, Ho KK, Kuntz RE; Saphenous vein graft Angioplasty Free of Emboli Randomized (SAFER) Trial Investigators. Randomized trial of a distal embolic protection device during percutaneous intervention of saphenous vein aorto-coronary bypass grafts. *Circulation*. 2002;105(11):1285-90.
17. Stone GW, Rogers C, Hermiller J, Feldman R, Hall P, Haber R, Masud A, Cambier P, Caputo RP, Turco M, Kovach R, Brodie B, Herrmann HC, Kuntz RE, Popma JJ, Ramee S, Cox DA; FilterWire EX Randomized Evaluation Investigators. Randomized comparison of distal protection with a filter-based catheter and a balloon occlusion and aspiration system during percutaneous intervention of diseased saphenous vein aorto-coronary bypass grafts. *Circulation*. 2003;108(5):548-53.
18. Coolong A, Baim DS, Kuntz RE, O'Malley AJ, Marulka S, Cutlip DE, et al. Saphenous vein graft stenting and major adverse cardiac events: a predictive model derived from a pooled analysis of 3958 patients. *Circulation*. 2008;117(6):790-7.
19. O'Gara PT, Kushner FG, Ascheim DD, Casey DE Jr, Chung MK, de Lemos JA, Ettinger SM, Fang JC, Fesmire FM, Franklin BA, Granger CB, Krumholz HM, Linderbaum JA, Morrow DA, Newby LK, Ornato JP, Ou N, Radford MJ, Tamis-Holland JE, Tommaso CL, Tracy CM, Woo YJ, Zhao DX, Anderson JL, Jacobs AK, Halperin JL, Albert NM, Brindis RG, Creager MA, DeMets D, Guyton RA, Hochman JS, Kovacs RJ, Kushner FG, Ohman EM, Stevenson WG, Yancy CW; American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2013;127(4):e362-425. Erratum in: *Circulation*. 2013;128(25):e481.
20. Welsh RC, Granger CB, Westerhout CM, Blankenship JC, Holmes DR Jr, O'Neill WW, Hamm CW, Van de Werf F, Armstrong PW; APEX AMI Investigators. Prior coronary artery bypass graft patients with ST-segment elevation myocardial infarction treated with primary percutaneous coronary intervention. *JACC Cardiovasc Interv*. 2010;3(3):343-51.
21. Ahmed JM, Dangas G, Lansky AJ, Mehran R, Hong MK, Mintz GS, et al. Influence of gender on early and one-year clinical outcomes after saphenous vein graft stenting. *Am J Cardiol*. 2001;87(4):401-5.
22. Mello BH, Oliveira GB, Ramos RF, Lopes BB, Barros CB, Carvalho EO, et al. Validação da classificação de Killip e Kimball e mortalidade tardia após infarto agudo do miocárdio. *Arq Bras Cardiol*. 2014;103(2):107-17.
23. Giugliano GR, Kuntz RE, Popma JJ, Cutlip DE, Baim DS; Saphenous Vein Graft Angioplasty Free of Emboli Randomized (SAFER) Trial Investigators. Determinants of 30-day adverse events following saphenous vein graft intervention with and without a distal occlusion embolic protection device. *Am J Cardiol*. 2005;95(2):173-7.
24. Mak KH, Challapalli R, Eisenberg MJ, Anderson KM, Califf RM, Topol EJ. Effect of platelet glycoprotein IIb/IIIa receptor inhibition on distal embolization during percutaneous revascularization of aortocoronary saphenous vein grafts. *Am J Cardiol*. 1997;80(8):985-8.
25. Roffi M, Mukherjee D, Chew DP, Bhatt DL, Cho L, Robbins MA, et al. Lack of benefit from intravenous platelet glycoprotein IIb/IIIa receptor inhibition as adjunctive treatment for percutaneous interventions of aortocoronary bypass grafts. *Circulation*. 2002; 106(24):3063-7.

26. Sanchez-Recalde A, Jiménez Valero S, Moreno R, Barreales L, Lozano I, Galeote G, et al. Safety and efficacy of drug-eluting stents versus bare-metal stents in saphenous vein grafts lesions: a meta-analysis. *EuroIntervention*. 2010;6(1):149-60.
27. Wiisanen ME, Abdel-Latif A, Mukherjee D, Ziada KM. Drug-eluting stents versus bare-metal stents in saphenous vein graft interventions: a systematic review and meta-analysis. *JACC Cardiovasc Interv*. 2010;3(12):1262-73.