

The Impact of Previous Revascularization on Clinical Outcomes in Patients Undergoing Primary Percutaneous Coronary Intervention

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ABSTRACT: While the impact of prior coronary artery bypass graft surgery (CABG) on in-hospital outcomes in patients with ST-elevation myocardial infarction (STEMI) has been described, data are limited on patients with prior percutaneous coronary intervention (PCI) undergoing primary PCI in the setting of an STEMI. The aim of the present study was to assess the effect of previous revascularization on in-hospital outcomes in STEMI patients undergoing primary PCI. Between January 2004 and December 2007, a total of 1649 patients underwent primary PCI for STEMI at four New York State hospitals. Baseline clinical and angiographic characteristics and in-hospital outcomes were prospectively collected as part of the New York State PCI Reporting System (PCIRS). Patients with prior surgical or percutaneous coronary revascularization were compared to those without prior coronary revascularization. Of the 1649 patients presenting with STEMI, a total of 93 (5.6%) had prior CABG, 258 (15.7%) had prior PCI, and 1298 (78.7%) had no history of prior coronary revascularization. Patients with prior CABG were significantly older and had higher rates of peripheral vascular disease, diabetes mellitus, congestive heart failure, and prior stroke. Additionally, compared with those patients with a history of prior PCI as well as those without prior coronary revascularization, patients with previous CABG had more left main interventions (24% vs 2% and 2%; $P<.001$), but were less often treated with drug-eluting stents (47% vs 61% and 72%; $P<.001$). Despite a low incidence of adverse in-hospital events, prior CABG was associated with higher all-cause in-hospital mortality (6.5% vs 2.2%; $P=.012$), and as a result, higher overall MACE (6.5% vs 2.7%; $P=.039$). By multivariate analysis, prior CABG (odds ratio, 3.40; 95% confidence interval, 1.15-10.00) was independently associated with in-hospital mortality. In contrast, patients with prior PCI had similar rates of MACE (4.3% vs 2.7%; $P=.18$) and in-hospital mortality (3.1% vs 2.2%; $P=.4$) when compared to the *de novo* population. Patients with a prior history of CABG, but not prior PCI, undergoing primary PCI in the setting of STEMI have significantly worse in-hospital outcomes when compared with patients who had no prior history of coronary artery revascularization. Thus, only prior surgical — and not percutaneous — revascularization should be considered a significant risk factor in the setting of primary PCI.

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Primary percutaneous coronary intervention (PCI) has become the default strategy for the treatment of patients with acute ST-elevation myocardial infarction (STEMI).^{1,2} The reported incidence of STEMI after prior coronary artery bypass grafting (CABG) ranges from 2%-10% in various reports^{3,4} and while infrequent, it has been associated with greater comorbidities and worse clinical outcomes.⁵⁻⁷ Early studies investigating revascularization in this setting showed poor angiographic success and increased mortality despite the use of thrombolysis or plain balloon angioplasty, while more recent studies utilizing contemporary methods continued to show an increased mortality among patients with prior CABG presenting with STEMI.^{3,4,7-13} Additionally, PCI was shown to reduce re-infarction rates when a native coronary vessel was found to be the infarct-related artery in patients with prior CABG, although there was no change in 30-day mortality.^{3,12} While the impact of prior CABG on the management of patients presenting with STEMI has been well established, there are limited data on patients presenting with a STEMI after prior coronary revascularization by PCI. To date, there has been no published analysis comparing these two groups to a patient population without prior coronary revascularization. In the present analysis, we sought to use a contemporary database to assess the clinical characteristics and in-hospital outcomes of patients with and without a prior history of surgical and percutaneous coronary revascularization undergoing primary PCI in the setting of an STEMI.

Methods

Data were prospectively collected from all patients who underwent PCI between January 1, 2004 and December 31, 2007 at four New York State academic medical centers participating in the New York State's Percutaneous Coronary Interventions Reporting System (PCIRS). Data elements in the registry include demographic information, insurance status, baseline clinical, angiographic and procedural characteristics, as well as in-hospital outcomes. To protect the anonymity of patients, all data were stripped of 20 identifiers by each individual center and submitted to a central databank for analysis. Each individual Institutional Review Board approved the study. Demographic and medical history data were extracted, including age, gender, race, ethnicity, ejection fraction, prior CABG, prior PCI, prior MI (defined as MI occurring more than 72 hours prior to PCI), stable angina, prior stroke or cerebrovascular accident, diabetes, peripheral vascular disease, chronic obstructive pulmonary disease, congestive heart failure, dialysis-dependent renal disease, serum creatinine, and glomerular filtration rate

Table 1. Demographics, baseline clinical, and angiographic characteristics.

	No Prior Revascularization (n = 1298)	Prior PCI (n = 258)	Prior CABG (n = 93)	P-Value
Demographics				
Age (years)	61 ± 13	62 ± 12	67 ± 12	<.001
Male gender	956 (73.6%)	194 (75.2%)	76 (81.7%)	.21
White	1165 (89.8%)	231 (89.5%)	87 (93.5%)	.51
African-American	78 (6%)	18 (7%)	1 (1.1%)	.51
Hispanic	91 (7%)	11 (4.3%)	4 (4.3%)	.51
Medical history				
Ejection fraction (%)	43 ± 12	44 ± 13	45 ± 11	.079
Diabetes mellitus	196 (15.1%)	69 (26.7%)	27 (29%)	<.001
Peripheral vascular disease	53 (4.1%)	25 (9.7%)	12 (12.9%)	<.001
Chronic lung disease	47 (3.6%)	17 (6.6%)	4 (4.3%)	.09
Congestive heart failure	74 (5.7%)	25 (9.7%)	10 (10.8%)	.02
Prior myocardial infarction	3 (0.2%)	1 (0.4%)	1 (1.1%)	.35
Prior cerebrovascular event	56 (4.3%)	9 (3.5%)	10 (11%)	.01
Chronic dialysis	6 (0.5%)	6 (2.3%)	0 (0%)	.004
Creatinine (mg/dL)	1.1 ± 0.8	1.3 ± 1.4	1.3 ± 1.1	.002
Glomerular filtration rate (mL/min/1.73 m ²)	79 ± 26	75 ± 28	71 ± 27	.002
Angiographic characteristics				
Left main	19 (1.5%)	5 (1.9%)	22 (23.7%)	<.001
Left anterior descending	942 (72.6%)	178 (69%)	69 (74.2%)	.45
Left circumflex	579 (44.6%)	122 (47.3%)	70 (75.3%)	<.001
Right coronary	806 (62.1%)	187 (72.5%)	67 (72%)	.002
Graft (arterial or venous)	n/a	n/a	20 (21.5%)	
Stent type				
Bare-metal stent	241 (18.6%)	52 (20.2%)	23 (24.7%)	.31
Drug-eluting stent	928 (71.5%)	158 (61.2%)	44 (47.3%)	<.001

Data given as mean ± standard deviation or number (percentage).

(GFR). Vessels intervened (and their respective branches) were grouped as left main, left anterior descending, left circumflex, right coronary artery, and arterial or venous bypass grafts.

The primary outcome for this study was major adverse cardiac and cerebrovascular events (MACCE), which was defined as a combined endpoint of in-hospital all-cause mortality, stroke, and non-fatal (recurrent) MI. Secondary outcomes included all-cause in-hospital mortality and hospital length of stay (LOS) measured in days.

Statistical analysis. Data were summarized with descriptive statistics — χ^2 test (or Fisher's exact test, when applicable) was used to compare categorical variables and one-way ANOVA was used for continuous variables. Univariate analyses were performed to compare characteristics of patients with prior PCI, prior CABG, and no prior revascularization. Multivariable logistic regression was utilized to evaluate the influence of previous revascularization on adverse cardiac events and in-patient mortality in patients undergoing PCI, while

controlling for demographic characteristics, medical history, and procedural characteristics. Predictors for the logistic regressions were selected based on statistical significance in the univariate analysis ($P < .1$) and included history of PCI, prior CABG, age, gender, left ventricular ejection fraction, congestive heart failure, prior cerebrovascular event, peripheral vascular disease, diabetes mellitus, chronic lung disease, serum creatinine, and hemodialysis. SPSS version 17.0 (SPSS, Inc) was used for data analysis and a two-tailed P -value of .05 was regarded as statistically significant.

Results

Between 2004 and 2007, a total of 25,025 patients underwent PCI at these medical institutions, and their data were prospectively collected and submitted as required by the New York State Department of Health. Of these patients, a total of 1649 underwent primary PCI in the setting of an STEMI and constituted our study population. In this group, a total

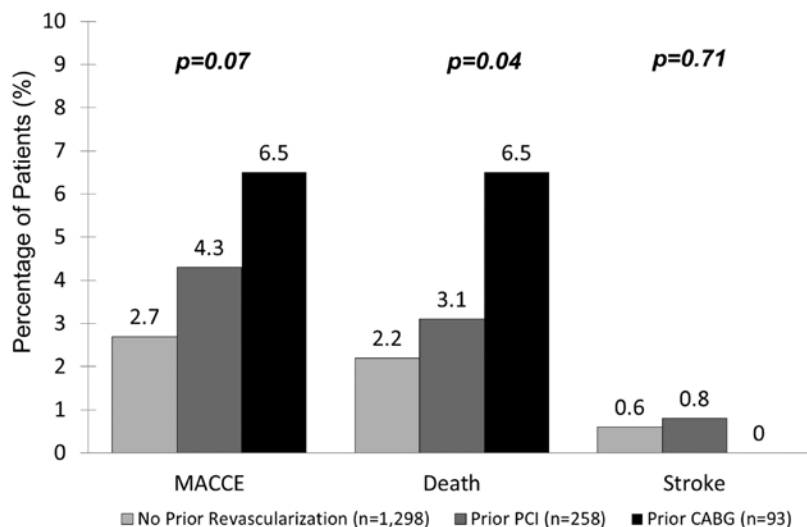


Figure 1. In-hospital major adverse cardiac and cerebrovascular events (MACCE), mortality, and stroke rates for patients without prior history of coronary revascularization (light grey bars), prior percutaneous coronary revascularization (PCI) (dark grey bars), and prior coronary artery bypass graft (CABG) (black bars).

of 1298 patients (78.7%) had no prior history of revascularization, while 93 patients (5.6%) had a history of previous CABG and 258 (15.7%) had a history of previous PCI. Considerable differences in baseline clinical and procedural characteristics were noted among these groups (Table 1). Patients with a history of prior CABG were significantly older, and had higher rates of peripheral vascular disease, diabetes mellitus, clinical heart failure, and prior stroke. With regard to procedural data, patients with prior CABG were more likely to have an intervention performed on the left main coronary artery than patients in the other groups (Table 1). Of the patients with previous bypass, PCI was performed on either an arterial or venous bypass graft in 22% of cases. Additionally, we observed lower rates of drug-eluting stent placement within the prior CABG cohort.

When compared to patients with no history of revascularization, STEMI patients with prior CABG had higher MACCE rates (2.7% vs 6.5%; $P=.039$), which was predominantly driven by significantly higher rates of in-hospital mortality (2.2% vs 6.5%; $P=.012$) (Figure 1). Length of stay was significantly longer for patients with a prior PCI than for those patients without prior revascularization or with prior CABG (6.6 ± 10.9 days, 5.5 ± 5.5 days, and 5.0 ± 6.0 days, respectively; $P=.002$). In a multivariable analysis, prior CABG was not an independent predictor of MACCE when controlling for several confounding factors (odds ratio [OR], 1.77; 95% confidence interval [CI], 0.67-4.70; $P=.250$), but was an independent predictor of in-hospital mortality (OR, 3.40; 95% CI, 1.15-10.00; $P=.027$). Among the 93 patients with prior CABG who presented with STEMI, in-hospital mortality was almost 4 times higher in patients who underwent PCI of a graft versus those that had PCI of a native vessel (4.1% vs 15%; $P=.11$). In addition, there was a strong trend toward prolonged length of stay in patients who underwent PCI of a saphenous or arterial graft (7.6 days vs 5.1 days; $P=.07$).

Analysis of the 258 patients with a history of prior PCI demonstrated that these patients had multiple comorbidities compared with patients without prior revascularization (Table 1). However, by multivariable analysis, prior PCI was not found to be a statistically significant predictor of MACCE (OR, 1.33; 95% CI, 0.60-2.92; $P=.483$) or of all-cause mortality (OR, 1.11; 95% CI, 0.43-2.86; $P=.584$).

Discussion

While STEMI patients with prior CABG are well known to have worse clinical outcomes than those without prior revascularization, a direct comparison between patients who underwent primary PCI in the setting of prior CABG or prior PCI has not yet been reported. The principal findings from the present analysis suggest that in a contemporary, unrestricted patient population presenting with STEMI and undergo-

ing primary PCI, patients with a prior history of CABG are: (1) usually older and have multiple comorbidities, including peripheral vascular disease, diabetes, and chronic obstructive lung disease; (2) are more likely to undergo intervention on a native vessel and not a bypass graft; (3) are more likely to be treated with bare-metal stents; and (4) have higher rates of in-hospital mortality without a significant increase in stroke or MI rates, when compared with patients with a prior history of PCI or patients with no previous history of coronary artery revascularization. Interestingly, these outcomes did not apply to patients with a history of prior PCI in this analysis. Instead, this cohort of patients had no significant difference in the rate of death, stroke, or periprocedural infarction when compared to a STEMI population without prior coronary revascularization, despite a significantly higher burden of comorbidities than those with no prior revascularization.

Our findings concur with previous studies that have shown higher mortality rates among patients with prior surgical bypass presenting with acute MI.^{7,9,14} Despite changes in revascularization strategies over the past 30 years, invasive therapies to treat acute coronary syndromes in patients with prior bypass surgery appear to have yielded less robust results than in other populations. In fact, Stone and colleagues already described in the Primary Angioplasty in Myocardial Infarction (PAMI-2) study that patients with a previous CABG undergoing primary PCI in the setting of an acute MI had significantly greater in-hospital mortality than patients without previous CABG, especially if the infarct-related vessel was a bypass conduit. However, by logistic regression analysis, only advanced age ($P=.004$), triple-vessel disease ($P=.004$), and Killip class ≥ 2 ($P=.02$) were independent predictors of in-hospital mortality in that study.¹³ In a more contemporary study of 128 STEMI patients with prior CABG, who were enrolled in the Assessment of PEXelizumab in Acute

Myocardial Infarction (APEX-AMI) trial, Welsh and colleagues reported that post-CABG patients are less likely to undergo acute reperfusion (only 79% underwent primary PCI), have worse angiographic outcomes following primary PCI, and have higher 90-day mortality rates (19.0% vs 5.7%; $P=.05$). This difference was even more apparent when the infarct-related artery was a bypass graft that was not successfully reperfused (23.1% vs 8.5%; $P=.03$).³ These results are similar to our current analysis, where in-hospital mortality rates for patients who underwent primary PCI of a graft were numerically roughly 4 times as high as those undergoing PCI of a native vessel. Likewise, Gurfinkel et al reported a significant reduction in hard endpoints, such as all-cause death and MI at 6 months in patients treated with an invasive approach in the Global Registry of Acute Coronary Events (GRACE).¹⁵ In this large, multinational, observational study of 3853 patients with prior bypass surgery presenting with an acute coronary syndrome, only 497 (12.9%) were managed invasively and the rest were treated medically. Despite significant differences in baseline characteristics, including a higher rate of STEMI in patients treated invasively (14% vs 27%; $P<.001$), in-hospital mortality was similar in both groups (3.4% vs 3.2%; $P=.86$). However, at 6-month follow-up, mortality was significantly higher in those patients treated medically (6.5% vs 3.4%; $P<.02$) as was the combined endpoint of death or MI (11% vs 5.8%; $P<.01$).

Whether these results apply to patients with a prior history of PCI has not been well defined. By the nature of vascular disease, patients with prior PCI are more likely to have more comorbidities than those without prior revascularization, a finding confirmed in our study. Despite considerable differences in baseline characteristics, however, these differences did not translate into a differential risk after STEMI. In fact, the cohort of patients presenting with STEMI who had a history of prior PCI had no statistically significant difference in in-hospital mortality or overall MACCE when compared to a population of patients presenting with STEMI in the absence of any prior revascularization.

Study limitations. The database utilized was derived from four New York State teaching hospitals and was designed to track quality of care and clinical outcomes. As all studies involving multicenter databases and registries, there is potential error in data entry and availability. Potential confounding comorbidities, including smoking status and family history of coronary artery disease, were not collected in this database, and information regarding long-term follow-up is not available, all of which are important limitations of this analysis. As such, deficiencies such as these limit the conclusions that can be drawn from our multivariate analysis. Additionally, there is no audit of data quality, and the low overall event rates limit effective statistical comparison.

Conclusions

In a contemporary cohort of STEMI patients undergoing primary PCI, a history of prior CABG was found to be an independent predictor of in-hospital mortality. In contrast, despite more comorbidities at the time of STEMI, patients with prior PCI had no significant difference in the rates of death, stroke, or periprocedural MI when compared to a STEMI population without prior coronary revascularization. Thus, only prior surgical — and not percutaneous — revascularization should be considered a significant risk factor in the setting of primary PCI.

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