Original Article

Immediate Results and Six-Month Clinical Outcome after Percutaneous Coronary Intervention in Patients with Prior Coronary Artery Bypass Surgery

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Abstract

Background: *Redo coronary artery bypass grafting surgery (CABG) is associated with a higher risk of mortality than the first operation. However, the impact of percutaneous coronary intervention (PCI) on the outcome in such patients is currently unclear. We evaluated the in-hospital and six-month clinical outcomes of post-CABG patients who underwent PCI in our center.*

Methods: *Between April 2008 and July 2009, 71 post-CABG patients (16 women and 55 men) underwent 110 stent implantations (74% drug-eluting stents) for 89 lesions. Sixty percent of the PCI procedures were performed on the native coronary arteries, 32% on graft arteries, and 8% on both types of vessels. Major adverse cardiac events (MACE) were recorded in hospital and at six months' follow-up.*

Results: *The procedural success rate was 93%, and the in-hospital MACE rate was 5.6 % (1 death, 3 myocardial infarctions). At 6 months, the incidence of MACE was 5.6% (no death or myocardial infarction, but 4 target lesion revascularizations) and 4 (5.6 %) in-stent restenoses. There was no statistically significant difference in the comparison of MACE between the patients treated in either native arteries or in the grafts (15% vs.12%, p value = 0.8). According to the univariate analysis, hypertension and the use of the bare metal stent vs. the drug-eluting stent were the significant predictors of MACE, whereas the multivariate analysis showed that only hypertension (OR = 3.7, 95% CI 3.4-4, p value < 0.048) was the independent predictor of MACE. The mean of the left ventricular ejection fraction had no effect on the incidence of MACE (p value = 0.9). The multivariate analysis showed hypertension (p value < 0.048) and the use of the bare metal stent (p value < 0.018) were the independent predictors of MACE. The chronic total occlusion (CTO) (p value < 0.01) was the independent predictor of the success rate. The prevalence of diabetes had no impact on the incidence of MACE according to the univariate analysis (p value = 0.9). Our multivariate analysis showed that hypertension and the use of the bare metal stent were the independent predictors of MACE and that chronic total occlusion was the independent predictor of the procedural failure rate.*

Conclusion: *PCI is preferable to redo CABG for post-CABG patients. The independent predictors of MACE were hypertension and bare metal stents.*

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Keywords: *Angioplasty • Coronary artery bypass • Treatment outcome • Reoperation*

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Introduction

Patients with previous coronary artery bypass grafting surgery (CABG) may require a repeat revascularization procedure because grafts may clot or develop atherosclerotic lesions. Moreover, the progression of atherosclerotic disease in the native arteries may eventually force patients with prior CABG to return with recurrent symptoms.[1, 2]

Redo CABG has a worse clinical outcome than does a first bypass operation,[3, 4] which accounts for the reported increase in the number of patients with prior CABG referred for percutaneous revascularization.[5] Previous studies have revealed that PCI has less procedural morbidity and mortality risk than does redo CABG, although it is associated with a greater requirement for subsequent revascularization procedures.[6, 7] Similarly, these patients have a greater rate of death, myocardial infarction (MI), and repeat revascularization after percutaneous coronary intervention (PCI) compared to patients without prior revascularization procedures.[8-10] Drug-eluting stents (DES) are effective at reducing the restenosis rate in patients with previous CABG undergoing PCI.[10]

The purpose of this study was to determine the immediate and six-month clinical outcomes in patients with a previous history of CABG undergoing PCI in our center.

Methods

Between April 2008 and July 2009, 71 consecutive patients with a previous history of CABG underwent PCI at our center. All the patients had a clinical indication for repeat revascularization. Case selection for PCI, instead of redo CABG, was left to the discretion of the interventional cardiologists. The patients included in this study were those considered to have high surgical risk for reoperation because of comorbidities or urgent situation and/or those with a coronary anatomy favorable for percutaneous procedures.

Exclusion criteria were the contraindications of antiplatelet agents. Choice of PCI on the grafts or the native coronary arteries was left to the discretion of the operators.

All the PCI procedures were perfumed according to standard techniques. All the procedural and technical details and choice of stent were left to the operators' judgment. Unfractionated heparin (70-100 u/kg) was administered before guide-wire insertion to achieve a clotting time > 250 sec. All the patients were pretreated with clopidogrel (600 mg) and ASA (325 mg). A loading dose of 600 mg of clopidogrel was administered if the patient was not pretreated. After the procedure, aspirin (325 mg/d) was continued for 3 months and then 80 mg/d indefinitely. Clopidogrel (75 mg/d) was administered for a period more than 3 or 12 months after bare metal stent (BMS) or DES implantation, respectively. Cardiac enzymes and twelve-lead electrocardiograms were determined routinely after intervention, at twelve-hour intervals during the first twenty-four hours.

Procedural success was defined as a thrombolysis in MI grade 3 flow (TIMI 3) and < 20% residual stenosis without major procedural or in-hospital complication (including death and requiring emergent surgery). MI was defined by a rise in the CK-MB fraction of more than 3 times the upper limit of normal.

Each patient was followed up for 6 months after the index procedure. Follow-up information was obtained by office visits or telephone interviews and by review of hospital charts. Angiographic follow-up and repeat revascularization was only performed if clinically indicated by symptoms or documentation of myocardial ischemia in non-invasive tests.

Major adverse cardiac events (MACE) were the in-hospital and six-month rates of death, MI, target vessel revascularization (TVR), and target lesion revascularization (TLR). Death was defined as mortality from any case.

Angiographic restenosis was defined by a diameter stenosis > 50% in the segment inside the stent or 5 mm proximal or distal to it at the angiographic follow-up. Stent thrombosis was defined as the angiographic documentation of thrombotic stent occlusion associated with a clinical event, an unexplained sudden cardiac death, or MI not clearly attributable to another coronary lesion. And finally, complete revascularization was defined as the successful treatment of the index vessel with no residual stenosis > 70% in any other coronary artery or in a graft supplying a territory with a more severe stenosis.

The categorical variables are presented as frequencies (percentages) and compared using the chi-square test or, when appropriate, Fischer's exact test. The continuous variables are presented as mean ± standard deviation (SD).

Univariate and multivariate logistic regression analyses were performed to identify the independent predictors of MACE at six months' follow-up. The odds ratio (OR) and its 95% confidence interval (CI) were computed for the outcome measures. A p value of less than 0.05 was considered statistically significant, and all the statistical tests were two-tailed. The statistical analyses were performed with SPSS 16.0 software (SPSS Inc. Chicago, IL).

Results

Tables 1 and 2 depict the baseline clinical and angiographic characteristics of the 71 patients with prior CABG.

The patients' mean age was 60.8 years, and 35.2% of the patients were diabetic. Unstable angina (40.8%) was the most common reason for PCI among all the patients. Five patients presented with acute MI for primary PCI, and two of them underwent rescue PCI a few hours after failed

Table 1. Clinical characteristics (n=71)*

Age (y)	60.8±9.4
Men	55 (78)
Hypertension	34 (47.9)
Diabetes mellitus	25 (35.2)
Hyperlipidemia	43 (60.6)
Smoking	24 (33.8)
Previous myocardial in fraction	42 (59.2)
Clinical presentation	
Stable angina	24 (33.8)
Unstable angina	29 (40.8)
Acute myocardial infarction	17 (23.9)
Left ventricular ejection fraction (%)	44.3±10.2
Time from bypass surgery (y)	16.3±4.2

*Date are presented as mean±SD or n (%)

Table 2. Procedural and angiographic characteristics (n=71)*

Target vessel	
Left main	4 (5.6)
LAD	11 (15.5)
LCX	23 (32.4)
RCA	21 (29.6)
SVG	20 (28.2)
LIMA	10 (14.1)
Type of treated vessel	
Unprotected native	37 (52.1)
Protected native	16 (22.5)
Grafts	30 (40.3)
Lesion Location	
Proximal	36 (50.7)
Mid	37 (52.1)
Distal	12 (16.6)
Anastomosis	13 (16.9)
Chronic total occlusion	12 (16.9)
Drug-eluting stent	53 (74.6)
Bare metal stent	27 (37.9)
ACC/AHA coronary artery lesions type	
Type A	16 (17.9)
Type B	40 (44.9)
Type C	33 (37.1)

*Date are presented as mean±SD or n (%)

LAD, Left anterior descending artery; LCX, Left circumflex coronary artery; RCA, Right coronary artery; SVG, Saphenous vein graft; LIMA, Left internal mammary artery; ACC/AHA, American College of Cardiology/American Heart Association

CABG. Most (90%) of the patients had multi-vessel disease. In total 89 lesions were treated with 110 stents (74.6% DES). Additionally, 16.9% of the lesions were chronic total occlusion (CTO); and in 18.3% of the cases, the culprit lesion was on the anastomosis site. The mean of the left ventricular ejection fraction (LVEF) was 44.3% ± 10.2%.

In total, 60% of the patients were treated on the native coronary arteries, 32% on grafts, and 8% on both types of vessels. Multi-vessel intervention was performed in 27% of the patients and complete revascularization was achieved in 86%. Glycoprotein IIb/IIIa inhibitor was used in 19% of the interventions. A majority (74.6%) of the patients underwent implantation with the DES. Distal protection devices were employed in 19% of the study population.

The procedural success rate was 93%. There were 3 (4.2%) cases of procedural-related MI (Table 3): 1 ST segment elevation MI (STEMI) due to distal embolization in the PCI of the saphenous vein graft (SVG) to the obtuse marginal (OM) artery (despite using a distal protection device), 1 non-ST segment elevation MI (NSTEMI) as a result of the irresolvable occlusion of a septal branch following the stenting of a protected left anterior descending coronary (LAD) artery, and finally one case of NSTEMI due to no-reflow phenomenon after stenting an SVG to the OM artery (distal protection device was not used).

Table 3. Incidence of complications during hospitalization*

Death	1 (1.4)
Myocardial infarction	3 (4.2)
Transient ischemic attack	1 (1.4)
Urgent revascularization	0
Vascular complication	1 (1.4)

*Data are presented as n (%)

In addition, there were 5 patients in whom the complex CTO lesions in the right coronary artery (2 cases), left circumflex artery (2 cases), and LAD (1 case) could not be crossed by the guide-wire. In one case, the PCI of the SVG to the LAD (total occlusion) was not successful due to the absence of a distal flow despite the use of a thrombectomy device, and nor was an attempt to revascularize the mid portion of the LAD (CTO). A transient ischemic attack occurred in PCI on the right coronary artery in a hypertensive 61-year-old male patient. Two patients experienced cardiogenic shock during the procedure. One of them was a female patient with a very low LVEF (25%); and during the revascularization of her complex circumflex artery lesions, she experienced cardiogenic shock. Resuscitation and stenting brought about some improvement in her condition and transferred to the CCU with a stable hemodynamic state; however, 5 days after the procedure, she died suddenly probably due to stent thrombosis. The other one was a 60-year-old man, who presented with chronic stable angina, left main artery lesion, and circumflex artery CTO. The patient's hemodynamic state suddenly deteriorated during the attempt for crossing the CTO lesion, but resuscitation and the stenting of the left main artery led to an improvement in his condition and he was discharged from hospital without any complication.

There was no urgent CABG during the hospital course in our patients. One patient had atrioventricular fistula (AVF) at the site of catheterization after PCI, which required observation.

Clinical follow-up was available in all the patients. During the follow-up, MACE occurred in 4 (5.6%) patients (Table 4). There was no death or MI, but there were 4 patients with repeat revascularization. One patient underwent redo CABG six months after PCI on the LAD due to recurrent symptoms. The second patient, who had had a BMS installed, underwent repeat TLR on the native vessel (right coronary artery) four months subsequently. The third patient, who had also had a BMS installed, had TLR for the SVG on the OM three months later. The last patient, who had had a BMS installed in the left circumflex coronary artery (LCX), required TLR about six months after the first procedure. The BMS was utilized in 3 cases in the first time.

Table 4. Incidence of MACE at 6-months' follow-up*

Death	0
Myocardial infarction	0
Target lesion revascularization	4 (5.6)
Total	4 (5.6)

*Data are presented as n (%)
MACE, Major adverse cardiac events

There was no statistically significant difference in the comparison of MACE between the patients treated in either native arteries or in the grafts (15% vs. 12%, p value = 0.8). According to the univariate analysis, hypertension and the use of the BMS vs. DES were the significant predictors of MACE; whereas the multivariate analysis showed that only hypertension (OR = 3.7, 95% CI: 3.4-4, p value < 0.048) was the independent predictor of MACE. The mean of LVEF had no effect on the incidence of MACE (p value = 0.9). The multivariate analysis showed hypertension (p value < 0.048) and the BMS (p value < 0.018) were the independent predictors of MACE. The CTO (p value < 0.01) was the independent predictor of the success rate. The prevalence of diabetes had no impact on the incidence of MACE according to the univariate analysis (p value = 0.9).

Discussion

Our immediate results and early outcome showed the safety and efficacy of percutaneous revascularization in post-CABG patients. In our consecutive series of high-risk patients, the procedural success rate was 93%, while the in-hospital MACE incidence was 5.6%. These patients had a high prevalence of diabetes mellitus, multi-vessel disease, left ventricular dysfunction, and complex lesion. The incidence of clinical TLR at 6 months was 5.6%. Only hypertension and BMS were found to be the independent predictors of MACE; however, the LVEF, diabetes mellitus, or multi-vessel PCI were not adversely effective, suggesting that in these patients they are not the determining factors in the outcome. Also, in the procedural success rate, only the CTO was the adverse predictor, although the success rate of the CTO in these patients (70%) was not different from that in patients with no prior CABG procedures.

This is one of the few studies conducted hitherto evaluating the clinical impact of PCI in patients with previous CABG after the introduction of the DES in clinical practice. Reported data on 2613 post-CABG patients who underwent PCI from 1980 to 1994 revealed 1.4% and 1.2% rates of in-hospital MI and mortality, respectively.[6] Cole et al. reported an incidence of 2.9% of adverse events during hospitalization in 1123 post-CABG patients undergoing PCI from 1985 to 1999;[11] and more recently, Bourassa et al. reported a 5.3% rate of early MACE.[8] One study on 91 patients from 2005 to 2006 revealed 3.3% and 18.6% rates of in-hospital and one-year MACE, respectively; the procedural success rate was 95.6%.[12] The rate of in-hospital events found in our study is low in comparison with the data from these reports. Nonetheless, other studies have revealed higher rates of in–hospital complications. Mathew et al. reported a 14% incidence of immediate MACE in 1784 post-CABG patients undergoing PCI between 1990 and 1998.[5]

Previous studies have shown no overall mortality difference between post-CABG patients treated with different revascularization methods at mid or long-term follow-up.[5, 6, 11, 13] Nevertheless, in these studies, the early clinical benefit of PCI, compared to redo-CABG, is eroded over time because of the increased need for repeat revascularization procedures in those patients treated with PCI.[6, 7, 11] Similarly some authors have demonstrated that post-CABG patients have greater rates of subsequent revascularization procedures after PCI compared to patients with no prior bypass surgery at mid and long-term follow-up.[1, 9]

Be that as it may, patterns of PCI have changed since the completion of these studies, mainly because of the introduction of the DES into clinical practice.[14] The DES is known to markedly reduce the rate of restenosis and repeat revascularization procedures.[15, 16] At present, the percentage of patients undergoing DES implantation in routine clinical practice is estimated at 70-80%.[15, 17] Scot et al. showed that the rates of repeat revascularization and MACE were significantly lower in patients treated with the DES than in those treated with the BMS.[18, 19] A total of 68% of the consecutive post-CABG patients included in our study were treated with the DES. This was translated in to a relatively low incidence of clinically-driven TLR at 6 months. In addition, the total MACE rate was significantly higher with the BMS than with the DES.

As the use of the DES has expanded for high-risk patients such as those with previous CABG, concerns have raised regarding the long-term risk of in-stent restenosis.[20] Recent reports have demonstrated a higher long-term risk of adverse events after the discontinuation of thienopyridine therapy in patients treated with the DES compared with those treated with the BMS.[21] However, several other studies and recent

analyses of pivotal trials of the DES have demonstrated that there is no increase in late events compared with the use of the BMS, although there is evidence of a small increase of 0.2% to 0.4% in late stent thrombosis for the DES.[22] In our study, despite the high percentage of patients receiving the DES, there were only 4 (5.6%) cases of late in-stent restenosis, both of them occurring with the BMS. There was also one in-hospital stent thrombosis with the BMS. Abbot et al. demonstrated that, although the efficacy and safety of the DES might be inferior in the off-label use compared to that in the on-label use, the DES is still superior to the BMS used in the same setting.[23] Other authors have also demonstrated that the DES use in an off-label situation is safe and not associated with an increased rate of stent thrombosis, MI, or death.[24, 25] In our study, most of our DES usage was off-label, but as was mentioned above, the incidence of in-hospital and six-month MACE was low.

Adams et al. reported good results of rescue PCI following failed CABG.[26] Successful primary PCI was performed in 5 patients in our study and two of them were rescue PCI for acute inferior MI several hours following failed CABG with no in-hospital or mid-term follow-up complications.

The CTO remains one of the most challenging problems for interventionists as the procedural success rate and acute outcome are still relatively poor.[12, 27] But recently Meliga et al. reported good long-term outcomes in both SVG and native CTO lesions.[28] We had 12 lesions of the CTO with a 70% success rate of reopening and with no significant mid-term MACE difference with other lesions (p value = 0.8).

The main limitation of our study is that it was performed in a single center with a small group of patients. This may cause some bias in the prediction of adverse outcomes and preclude a comparison of outcomes between the different subgroups of patients. Second, the indication for PCI (instead of redo-CABG or conservative treatment) was not prospectively defined, but the decision for a secondary revascularization strategy was made on a case-by-case basis after repeating angiography at the cardiologist's discretion. Third, the duration of the follow-up of our patients was short.

It is also deserving of note that the small power of this study in addition to the aforementioned weaknesses may have led to hypertension having a statistically independent role in restenosis.

Conclusion

The number of patients with previous CABG requiring repeat revascularization procedures is steadily increasing. The continual refinement of percutaneous therapies for coronary artery disease has contributed to a significant reduction in cardiovascular events in recent years. Our study demonstrates that PCI can be safely and effectively performed in post-CABG patients.

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