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Management of coronary insufficiency after coronary artery bypass graft surgery

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Objective
The aim of this work was to study the management of coronary insufficiency in patients with prior coronary artery bypass grafting (CABG) either by medical treatment, by redo-CABG or by percutaneous coronary intervention (PCI).

Background
Coronary insufficiency after CABG is a problem, and there are three different strategies for its management: medical treatment, redo-CABG, and PCI.

Patients and methods
This is a prospective nonrandomized study conducted at ASSALAM International Hospital on 62 patients with prior CABG who were referred for coronary angiography for the evaluation of chest pain and were followed for 1 year to assess the occurrence of major adverse cardiac event and recurrent chest pain after a physician-directed management choice.

Results
Of the patients included, 15 (24.2%) were advised for intensification of medical treatment, six (9.7%) were referred for redo-CABG, whereas 41 (66.1%) patients underwent PCI. Management of post-CABG coronary insufficiency depends on several factors including the date since CABG, the extent of native coronary artery disease, the percentage of venous graft diseased, and the presence of diseased left internal mammary artery supplying LAD. There was no significant difference in the outcome with regard to recurrent chest pain or major adverse cardiac event between these groups.
However, procedural success was significantly higher in PCI to native coronary arteries (96.8%) than in PCI to saphenous vein graft (70%).

Conclusion
In patients with coronary insufficiency after CABG, there was no significant difference in the patient outcome between different management strategies including medical treatment, redo-CABG or PCI.

Keywords:
coronary insufficiency, management strategy, percutaneous coronary intervention, post coronary artery bypass graft, redo coronary artery bypass grafting

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Introduction

Although short-term outcomes of coronary artery bypass grafting (CABG) are generally excellent, patients remain at risk for future cardiac events due to the progression of the native coronary disease and/or coronary bypass graft failure [1]. Over half of the saphenous vein grafts (SVGs) are occluded at 10 years after CABG and an additional 25% show significant stenosis at angiographic follow-up [2]. In addition, diseased grafts represent an increasing proportion of culprit lesions, and acute graft occlusion may cause acute coronary syndromes (ACSs) [3].

The use of SVG, arterial grafts or both during CABG depends largely on the site of anatomic obstruction, the availability of good quality conduits, patient preferences, and the clinical condition of the patient. Adequate arterial conduits are not always available; in contrast, SVGs are usually of good quality and caliber and are easily harvested, and are thus commonly used [2].

Many patients with recurrent stable angina after CABG can be treated medically for their symptoms and risk factor reduction. Evaluation for ischemia is as in other patients with stable angina without prior CABG. However, early diagnostic angiography is suggested because of the different anatomic possibilities – that is, graft stenosis or progression of native vessel disease in nonbypassed vessels can lead to recurrent ischemia [4].

Hence, we aimed to study the management of coronary insufficiency in patients with prior CABG either by medical treatment, by redo-CABG or by percutaneous coronary intervention (PCI) with 12 months' follow-up regarding recurrent chest pain and the occurrence of major adverse cardiac events (MACEs).

Patients and methods

This is a prospective nonrandomized study that included 62 patients who were referred for coronary angiography at ASSALAM International Hospital from January 2011 to June 2012 due to recurrent chest pain after CABG and were followed till June 2013 for recurrent chest pain and occurrence of MACE. All patients had objective evidence of coronary insufficiency that was either functional, by positive stress testing (stress MPI, stress dobutamine echocardiography or dynamic ECG changes with or without positive cardiac biomarkers), or anatomical, by multislice computed tomography coronary angiography with the presence of diseased grafts or diseased nongrafted native vessels. Patients who had other indication for cardiothoracic surgery, those who were lost to follow-up or patients presenting with heart failure were excluded from the study.

All the study patients were subjected to the following after taking a written consent: history taking focusing on data on the previous CABG including the time from surgery to symptom presentation, the type of grafts (internal mammary artery, radial artery, or venous grafts), and the number and the site of grafts. Also, coronary angiography was performed to assess the type and the number of grafts and the disease extent in native and graft vessels.

Then, according to the method of management, patients were referred for either intensification of medical treatment, redo-CABG, or PCI.

If PCI was the treatment of choice, then a comparison between PCI of the native coronary arteries with PCI of the vein grafts was performed regarding the type of stents [bare metal stent (BMS) vs. drug-eluting stent (DES)], the number of stents per patient, the occurrence of no reflow, which is defined as inadequate myocardial perfusion through a given segment of the coronary circulation without angiographic evidence of mechanical vessel obstruction [5], and procedural success, defined as the achievement of angiographic success (final residual stenosis <30% with thrombolysis in myocardial infarction flow grade 3) without in-hospital MACE [6].

Then, patients were follow-up for 12 months for the occurrence of chest pain or MACEs, which were defined as cardiac death, AMI, and target lesion revascularization (TLR), either percutaneous or surgical [6].

Statistical analysis

(1) Descriptive statistics were represented as percentage, means (X), and SD.

(2) For analytic statistics, Pearson's correlation analysis was used to show the strength and the direction of association between two quantitative variables; the χ^2-test, Fisher's exact test, one-way analysis of variance (F) test, the Kruskal–Wallis test, and the post-hoc test were also used, with the following levels of significance: P value less than 0.05, significant; P value less than 0.001, highly significant; and P value more than 0.05, nonsignificant [7].

Results

The study population comprised 62 patients with a mean age of 60.0 ± 9.4 years: 49 (79%) patients were male and 13 (21%) were female; 16 (25.8%) patients were current cigarette smokers, 43 (69.4%) patients were hypertensive, 32 (51.6%) patients were diabetic, and 10 (16.1%) patients had a positive family history, and the mean BMI was 30.62 ± 4.36 kg/m^2 (Table 1).

Regarding the presentation, 33 (53.3%) patients presented with chronic stable angina (CSA), whereas 29 (46.7%) patients presented with ACS, of whom, 16 (25.8%) patients had unstable angina, 11 (17.7%) had non-ST-elevation myocardial infarction, and only two (3.2%) patients presented with ST-elevation myocardial infarction (Table 2).

Regarding the method of investigation and detection of coronary insufficiency, either functional or anatomical, before coronary angiography, 25 (40.3%) patients had multislice computed tomography, 18 (29.0%) patients had single photon emission computed tomography myocardial perfusion imaging, 17 (27.4%) patients were identified to have myocardial ischemia by the presence

Table 1 Distribution of the studied patients with regard to their risk factors

Risk factors	*n* (%) (*n* = 62)
Age (years)	
Mean ± SD	60.0 ± 9.4
Range	36–81
BMI (kg/m^2)	
Mean ± SD	30.62 ± 4.36
Range	21.20–39.20
Duration since CABG (years)	8.08 ± 4.90 (2–19)
Sex	
Male	49 (79)
Female	13 (21)
Smoking	16 (25.8)
Hypertension	43 (69.4)
Diabetes	32 (51.6)
Family history	10 (16.1)
Obesity (BMI >30 kg/m^2)	32 (51.6)

CABG, coronary artery bypass grafting.

of new ECG changes with or without positive cardiac biomarkers, and only two (3.3%) patients underwent stress echo-dobutamine (Table 2).

Regarding the angiographic findings of the patients, native vessel evaluation revealed that 16 (25.8%) patients had significant LM disease (luminal stenosis ≥ 50%), 50 (80.6%) patients had three vessels diseased or more, with the mean number of native vessels diseased being 2.72 ± 0.54/patient.

However, graft vessel evaluation revealed that the mean number of grafts per patient was 2.96 ± 0.88. The mean number of VG per patient was 2.09 ± 0.64, with a total of 115 venous grafts, of which 66 (56%) grafts were diseased or totally occluded. The mean number of diseased VG per patient was 1.58 ± 0.63.

Sixty patients had arterial grafts, with a total of 69 grafts: 60 patients had left internal mammary artery (LIMA) (96.8%), of whom seven (11.6%) patients had the LIMA graft diseased. Radial graft was used in eight (12.9%) patients, of whom five (62.5%) patients had the radial graft occluded or diseased. Only one patient had right internal mammary artery that was patent (Table 3).

Regarding the management strategy of patients, 15 (24.2%) patients were advised for intensification of medical treatment only, six (9.7%) patients were referred for redo-CABG, whereas 41 (66.1%) patients underwent PCI (Table 4).

The 12-month follow-up data revealed that 20 (32.3%) patients had recurrent attacks of chest pain from mild tolerable chest pain to intolerable chest pain that required hospitalization and intervention (Table 4).

Eleven (17.7%) patients had MACE on the 12-month follow-up, of whom five (8.1%) patients suffered cardiac death, three (4.8%) patients had AMI, and three (4.8%) patients had TVR (Table 4).

Procedural success was significantly higher in PCI to native coronaries (96.8%) than in PCI to SVG (70%) (Table 5).

No reflow occurred in three (30%) patients in the PCI to SVG group, which was higher than the native PCI

Table 2 Distribution of patients with regard to their method of detection of ischemia and clinical presentation

	n (%) (*n* = 62)
Methods of detection	
MSCT	25 (40.3)
SPECT	18 (29.0)
ECG	17 (27.4)
Echo-dobutamine	2 (3.3)
Presentation	
CSA	33 (53.3)
UA	16 (25.8)
NSTEMI	11 (17.7)
STEMI	2 (3.2)

CSA, chronic stable angina; MSCT, multislice computed tomography; NSTEMI, non-ST-elevation myocardial infarction; SPECT, single photon emission computed tomography; STEMI, ST-elevation myocardial infarction; UA, unstable angina.

Table 3 Angiographic data of the native and the graft vessels

Angiographic data/patients	Mean ± SD
Number of diseased natives	2.72 ± 0.54
Number of SVG	2.09 ± 0.64
Number of arterial graft	1.15 ± 0.36
Total number of grafts	2.96 ± 0.88
Diseased or occluded venous graft	1.58 ± 0.63
Number of patent venous graft	1.37 ± 0.49

SVG, saphenous vein grafts.

Table 4 Distribution of patients regarding the management strategy and the 12-month follow-up

	n (%)
Management strategies	
Medical treatment	15 (24.2)
Redo-CABG	6 (9.7)
PCI	41 (66.1)
Follow-up data	
Recurrent chest pain	20 (32.3)
MACE	12 (19.3)

CABG, coronary artery bypass grafting; MACE, major adverse cardiac event; PCI, percutaneous coronary intervention.

Table 5 Comparison between percutaneous coronary intervention to native coronaries with venous grafts

	PCI [*N* (%)]		Test	*P* value
	Native (*n* = 31)	SVG (*n* = 10)		
Periprocedural GP IIb/IIIa inhibitor	11 (35.5)	4 (40.0)	Fisher's exact 0.06	1.0
Presentation				
CSA	16 (51.6)	3 (30.0)	$\chi^2$5.99	
ACS	15 (48.3)	7 (70.0)		0.050 (S)
Type of stent				
DES	27 (87.1)	8 (80)	Fisher's exact 0.30	0.622
BMS	4 (12.9)	2 (20)		
No reflow	4 (12.9)	3 (30.0)	Fisher's exact 1.15	0.332
Procedural success	30 (96.8)	7 (70.0)	Fisher's exact 6.16	0.038
Recurrent chest pain	10 (32.3)	5 (50.0)	Fisher's exact 1.02	0.453
MACE	6 (19.4)	3 (30.0)	Fisher's exact 1.31	0.420

ACS, acute coronary syndrome; BMS, bare metal stent; CSA, chronic stable angina; DES, drug-eluting stent; GP IIb/IIIa, glycoprotein IIb/IIIa; MACE, major adverse cardiac event; PCI, percutaneous coronary intervention; S, significant; SVG, saphenous vein graft.

group with four (12.9%) patients, but the difference did not reach statistical significance (Table 5).

Periprocedural glycoprotein IIb/IIIa antagonists were used slightly more in the SVG group (40%) than in the native group (35.5%) (Table 5).

Recurrent chest pain on the 12-month follow-up occurred more frequently in patients with PCI to SVG (50%) compared with the native PCI (32.3%), but the difference did not reach statistical significance (Table 5).

Occurrence of MACE on the 12-month follow-up occurred more frequently in patients with PCI to SVG (30%) compared with native PCI (19.4%), but the difference did not reach statistical significance (Table 5).

On comparing the three management strategies, it was found that the date since CABG was significantly longer in patients referred for redo-CABG (11.50 ± 5.57 years) than in the PCI group (8.70 ± 4.72 years), and the least duration was found in the medical treatment group (5.03 ± 3.71 years) (Table 6).

Also, the percentage of venous grafts diseased, the presence of diseased LIMA and the mean number of diseased native coronaries were significantly higher in the redo-CABG group than in the PCI group and the medical treatment group (Table 6).

In the hospital, glycoprotein IIb/IIIa antagonists were used more frequently in patients who underwent PCI. There was no significant difference in the outcome regarding recurrent chest pain or MACE between the three strategies; there was a trend toward improvement of chest pain in patients in whom redo-CABG was the preferred strategy (Table 6) (Figs 1–3).

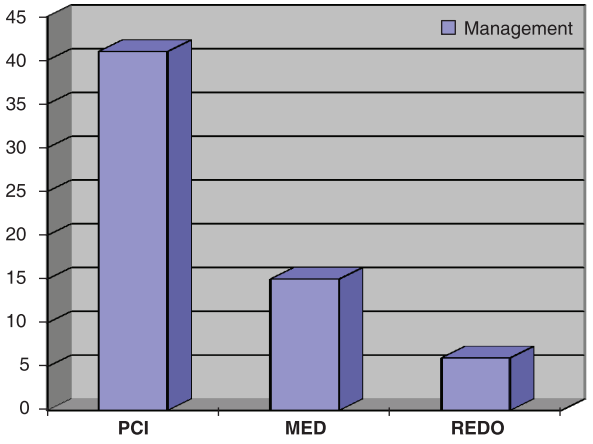
Discussion

Regarding the management strategy, 15 (24.2%) patients in our study were advised for intensification of medical treatment, and only six (9.7%) patients were referred for redo-CABG, whereas 41 (66.1%) patients underwent PCI.

Morrison *et al.* [1] revealed that patients were distributed according the method of management into 155 patients who had repeat CABG, 207 patients who were advised to intensify medical treatment only and the highest number were referred for PCI (357 patients).

Harskamp *et al.* [8] found that 84.7% of the patients were referred for PCI, whereas 15.3% of the patients were referred for redo-CABG.

Figure 1



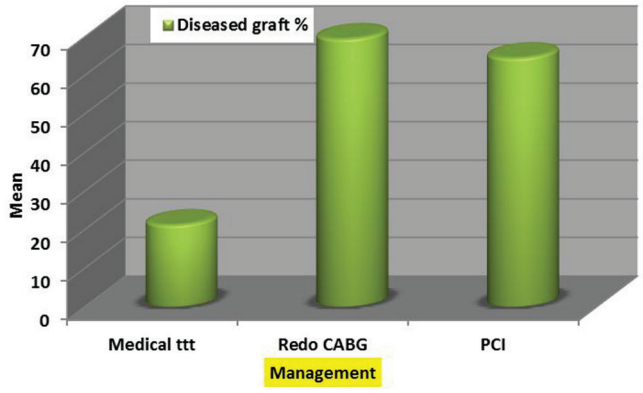
Different methods of management. MED, medical treatment; PCI, percutaneous coronary intervention; REDO, redo coronary artery bypass grafting.

Table 6 Comparison between different strategies

	Management [*n* (%)]			Test of significance	*P* value
	Medical ttt (*n* = 15)	Redo-CABG (*n* = 6)	PCI (*n* = 41)		
Presentation					
CSA	10 (66.7)	4 (66.7)	19 (46.3)	χ^2 6.11	0.191
ACS	5 (33.3)	2 (33.3)	22 (53.7)		
In-hospital GP IIb/IIIa inhibitors	1 (6.7)	1 (16.7)	15 (36.6)	χ^2 5.32	0.070
Duration since CABG (years)	5.03 ± 3.71	11.50 ± 5.57	8.70 ± 4.72	Kruskal–Wallis 10.33 *P* = 0.006 (S)	Post-hoc Med# CABG < 0.05 Med# PCI <0.05
Number of native vessel disease	2.53 ± 0.74	3.0	2.75 ± 0.48	1.78	0.177
% of venous grafts diseased	21.20 ± 40.20	69.43 ± 40.02	64.46 ± 34.69	Kruskal–Wallis 9.54 *P* = 0.008 (S)	Post-hoc Med# CABG <0.05Med# PCI <0.05
LIMA diseased	1 (6.7)	4 (66.66)	2 (4.9)	χ^2 17.78	<0.001 (HS)
Recurrent chest pain	5 (33.3)	0 (0.0)	15 (36.6)	χ^2 3.21	0.200
MACE	2 (13.3)	1 (16.7)	9 (22)	χ^2 1.58	0.452

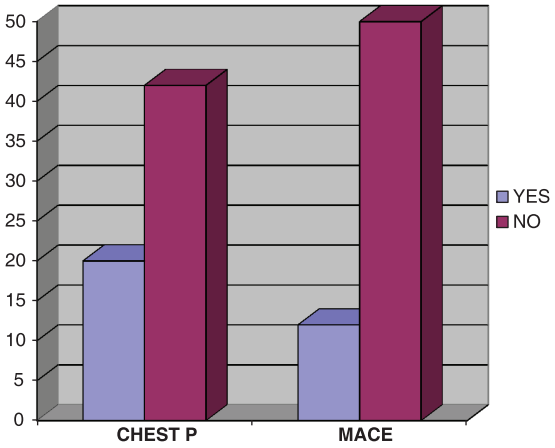
ACS, acute coronary syndrome; CABG, coronary artery bypass grafting; CSA, chronic stable angina; GP IIb/IIIa, glycoprotein IIb/IIIa; HS, highly significant; LIMA, left internal mammary artery; MACE, major adverse cardiac event; PCI, percutaneous coronary intervention; S, significant.

Figure 2



Difference between the three groups regarding the duration of saphenous vein graft disease. CABG, coronary artery bypass grafting; PCI, percutaneous coronary intervention.

Figure 3



Twelve-month follow-up with regard to recurrent chest pain and MACE. Chest p, chest pain; MACE, major adverse cardiac event.

The higher referral for PCI compared with redo-CABG is due to the fact that reoperation has a higher mortality and morbidity [1].

In our study, the mean duration since CABG was significantly higher in the redo group than in the PCI group and the least in the medical treatment group, with the *P* value less than 0.05.

In agreement with our study, Brener *et al.* [9] found that the time from CABG was higher in the redo group than in the PCI group.

Our study revealed that patients who were referred for redo-CABG had more extensive native vessel disease, a higher percentage of LIMA disease, and a higher number and percent of diseased SVGs compared with patients who underwent PCI, whereas patients who were advised to continue on medical treatment had only the least of the above parameters.

Also, in accordance with our study, in the Brener *et al.*'s [9] study, the choice of treatment strategy was largely determined by the coronary anatomy, wherein the most important factors to perform redo-CABG were:

(i) More diseased or occluded grafts,
(ii) The absence of a prior myocardial infarction,
(iii) A lower left ventricular ejection fraction,
(iv) A longer interval from first CABG (15 vs. 6 years),
(v) More total occlusions in native coronary arteries, and
(vi) The absence of a patent mammary artery graft [9].

In accordance with our study, Morrison *et al.* [1] also found that in the physician-directed arm, 71% of the patients who were referred for redo-CABG had disease in three vessels, whereas only 58% of the patients who were referred for PCI had disease in three vessels.

The choice of the revascularization target in patients with previous CABG is usually dictated by anatomical considerations with operators showing preference to the most convenient revascularization pathway [10].

Our study revealed that on the 12-month follow-up, recurrent chest pain from mild tolerable chest pain to agonizing chest pain that required intervention did not show a statistically significant difference between the three groups, with a trend toward improved symptoms in the redo-CABG group.

In accordance with our study, Morrison *et al.* [1] found that in the physician-directed arm, survival free of unstable angina was significantly higher in the redo-CABG group (61%) than in the PCI group (43%).

However, the occurrence of MACE did not show a significant difference between the groups with different management strategies.

Also, in agreement with our study, Brener *et al.* [9] found that after 1 year's follow-up, MACE occurred in 27.8% of the patients who had PCI and it was higher than that in patients who had redo-CABG (25.3%), but with no statistical significance.

In patients who underwent PCI, our study revealed that regarding the target vessel for PCI, a high percentage of the patients had PCI for the native (75.6%), whereas 24.4% of the patients had PCI to the venous grafts, and only 3.2% of the patients had PTCA to the LIMA graft.

In accordance with our study, Brilakis *et al.* [11] found that the PCI target vessel in prior CABG patients was only a native coronary artery in 62.5% and at least one bypass graft in 37.5% of the cases. Most of the target grafts were SVGs (34.9%), and less frequently arterial grafts (2.5%) or both arterial grafts and SVGs (0.2%).

However, native coronary artery PCI was performed in only 56% of 142 patients as reported by Varghese *et al.* [12].

Traditionally, PCI of a native coronary artery is preferred to SVG PCI that supplies the same territory, if feasible, as SVG PCI carries a higher acute and long-term risk [12,13].

Comparison between PCI to native coronaries and PCI to SVG revealed the following:

Our study found that the procedural success was significantly higher in the PCI to native group than in the PCI to SVG group.

However, unlike our study, Xanthopoulou *et al.* [10] found that procedural success was achieved in 94.3% of the patients with PCI to SVG and in 93.1% of the patients with PCI to the native vessels, with *P* value of 0.8.

Regarding the type of stents, DESs were used slightly more often in PCI to native coronaries than in PCI to SVG, and this was not statistically significant.

In accordance with our study, Xanthopoulou *et al.* [10] also found that patients with PCI to SVG were treated with a DES less frequently compared with patients with PCI to native vessels.

Varghese *et al.* [12] found that DESs were used for almost all native coronary lesions, but only half of the SVG lesions.

DES has become the mainstay of native vessel PCI due to its established superiority over BMS in reducing MACE, primarily by reducing restenosis and the need for TLR or TVR [14].

There is a debate about the benefit of DES use in PCI to SVG as the SOS trial concluded that the use of PES was associated with significantly better clinical outcomes than BMS in SVG lesions [14].

However, results from the RRISC study have raised concerns regarding the potential association with increased mortality in the DES group and attrition of the improvement in restenosis after 3 years [15].

Our study found that no reflow was higher in the PCI to SVG group (30%) than in the native PCI group (12.9%).

In accordance with our study, Varghese *et al.* [12] found a significantly higher incidence of no reflow after SVG PCI than after native coronary PCI.

These results are mostly due to the fact that SVG lesions often have high-risk angiographic features, such as ulceration or thrombus [13].

Regarding the mean duration since CABG, our study demonstrated a longer duration of symptom development in the SVG group compared with the native group.

In accordance with our study, Xanthopoulou *et al.* [10] found that symptoms presented later in patients with PCI to SVG compared with patients with PCI to native vessels.

Also, Varghese *et al.* [12] found that patients with PCI to native vessels presented earlier after CABG than patients in the PCI to SVG group.

Regarding the presentation, our study revealed that patients in the SVG group presented more frequently with ACS than CSA, whereas patients in the native group presented more frequently with CSA than ACS, and the presentation difference between the two groups was statistically significant with *P* value 0.05.

Varghese *et al.* [12] found that patients undergoing PCI of a native coronary artery are less likely to present with an ACS, whereas 78% of the SVG PCI patients presented with ACS.

Regarding the 12-month follow-up, our study found that recurrent chest pain on the 12-month follow-up was higher in the PCI to SVG group than in the native PCI group, but it was not statistically significant.

In disagreement with our study, Varghese *et al.* [12] found that patients with PCI to native coronaries had follow-up clinical outcomes similar to those of patients who underwent PCI to SVG.

Occurrence of MACE on 12 months' follow-up in our study was higher in the PCI to SVG group than in the native PCI group.

In accordance with our study, Bundhoo *et al.* [16] in a retrospective analysis of 161 post-CABG patients subjected to either graft-PCI or NV-PCI, at a mean follow-up of 13.5 ± 4.8 months, reported higher

TVR rates (15 vs. 4.9%; log-rank P = 0.03) and a higher incidence of MACEs (21.6 vs. 8.9%; log-rank P = 0.048) in the graft compared with the NV-PCI group.

Also in agreement with our study, Xanthopoulou *et al*. [10] found that on follow-up at a median duration of 28 (range, 2–83) months, patients with PCI to SVG had a significantly higher incidence of MACEs (43.2 vs. 19.6%; log-rank P = 0.001) compared with those who had PCI to native coronaries.

Although Tejada *et al*. [17] reported no difference in the incidence of MACEs, death, and TLR between patients subjected to PCI of either graft or native vessels, their study also involved a small sample of 84 consecutive patients with a midterm follow-up of 19.7 months [17].

Conclusion

In patients with coronary insufficiency after CABG, there was no significant difference in the patient outcome between management strategies including medical treatment, redo-CABG or PCI.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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