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Institutional report – Coronary

Risk of coronary surgery for hospital and early morbidity and mortality after initially successful percutaneous intervention

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Abstract

This study examines the influence of a successful PCI upon preoperative patient profile, peroperative management and postoperative, including one-year follow-up, results. From January 1999 through December 2001, 1141 patients (91%) underwent coronary artery bypass grafting (CABG) as the primary intervention for myocardial revascularization (group A) and 113 patients (9%) underwent primary CABG after an initially successful PCI (group B). Patients undergoing CABG after a failed PCI were not included. Patients in group B were statistically significant younger ($P=0.010$), with more peripheral arterial vascular ($P=0.015$) and renal disease ($P=0.036$). Left main coronary artery stenosis was significantly lower in group B ($P=0.004$). The number of diseased vessels did not differ between the two groups. However, less distal anastomoses were performed in group B ($P=0.001$). Postoperatively there was no statistically significant differences, in the percentages of myocardial infarction, arrhythmias, reinterventions, neurological, renal and pulmonary complications, and hospital mortality. One-year follow-up did not show any statistically significant differences in cardiac related mortality ($P=0.25$) or recurrent ischemic events ($P=0.27$). Multivariate analysis did not identify a successful PCI as a risk factor for early and late adverse outcomes. Previous PCI does not seem to result in a higher postoperative mortality or morbidity after CABG.

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1. Introduction

Since the introduction of percutaneous coronary intervention (PCI) as an alternative myocardial revascularization procedure to coronary artery bypass grafting (CABG) several studies have been published comparing the outcomes of CABG and PCI as the primary treatment for coronary artery disease [1–3]. At the same time reports have been published about the changing population being offered primary CABG [4–6]. Beside the increase of age and co-morbidity, there are an increasing number of patients with a previous successful PCI in the present population of patients undergoing CABG [5].

It is supposed that this cohort of patients with a previous PCI is at higher risk for CABG. However, only a few studies are available and contradictory: some authors suggest that initial PCI may complicate the operation and may increase postoperative morbidity and mortality [7]. Others describe no difference in postoperative morbidity and mortality [8].

The aim of our study was to examine if patients who had undergone previously successful PCI and required subsequent CABG do have a higher operative risk compared to patients treated by CABG as the primary intervention. Not

only hospital mortality and morbidity were analyzed, but also the results at one year postoperative.

2. Patients and methods

2.1. Patients

The Coronary Surgery Database at Radboud Hospital (CORRAD), a registry that stores pre-, peri-, postoperative, and follow-up data of all patients undergoing cardiac surgery at the University Medical Centre St. Radboud, Nijmegen, The Netherlands, was used to identify patients who had undergone primary isolated CABG from January 1999 through December 2001. 1141 Patients (91%) underwent CABG as the primary intervention (group A) for a myocardial revascularization and 113 patients (9%) who previously had undergone successful PCI required subsequent CABG (group B). A successful PCI was defined as dilation of a coronary stenosis (or stenoses) such that the residual luminal narrowing was less than 10% and unassociated with a flow-limiting dissection or the need for immediate CABG. Patients undergoing an emergency-CABG after a failed PCI and patients who had unsuccessful PCI were not included in group B.

Patient baseline characteristics analysed included patient gender, age and diabetes mellitus, hypertension, hyperlipidemia, smoking history and family history of coronary

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artery disease as risk factors for ischemic heart disease. Preoperative co-morbidity included peripheral ischemic vascular, neurological, renal and pulmonary disease. Preoperative cardiac status included myocardial infarction, arrhythmia, left main coronary artery stenosis and the degree of coronary vessel disease (1-, 2- or 3-vessel disease at the time of indication for CABG) and decreased left ventricular function.

In both groups the duration of extracorporeal circulation (ECC) and aortic cross-clamp time (AoX), the number of grafts and distal anastomoses and the number of endarterectomies were compared.

Postoperative complications assessed included arrhythmia, perioperative myocardial infarction, reintervention and neurological, renal and pulmonary complications, and also hospital mortality. The definitions of these patient characteristics are described in Table 1.

2.2. Follow up

Our follow-up concerned the first postoperative year and was complete except for 1 patient of group A (0.09%). These data are the results of our yearly-organized follow-up. This follow-up consists of a written survey directed to all patients. In this survey mortality, and non-fatal cardiac events are registered. Mortality was divided in cardiovascular related and non-cardio-vascular related mortality. A

new non-fatal event was registered as a new myocardial infarction, the return of angina pectoris, a positive treadmill test after a negative one, coronary angioplasty, reintervention, congestive heart failure, arrhythmia or stroke.

2.3. Statistic analysis

Characteristics of patients are presented as percentages for dichotome variables, and as mean \pm standard deviation, and range for numerical variables. Differences in percentages were tested with the chi-square test, and numerical variables were tested with the *t*-test. To identify if a PCI is an independent significant risk factor for negative outcome, multivariate logistic regression analysis was used to identify pre- and postoperative risk factors that independently contributed to hospital mortality, cardiac related mortality and non-fatal cardiac events at one year postoperative. Statistical significance was assumed at $P \leq 0.05$.

3. Results

3.1. Patient characteristics at baseline

Patient characteristics before CABG are outlined in Table 2. There were no significant differences between group A and B for gender and for the incidence of diabetes mellitus, hypertension, hyperlipidemia, smoking history and family

Table 1
Definitions of patient characteristics and events

Age	Years
Gender	Male, female
Diabetes mellitus	Diet-controlled, oral therapy or insulin dependent diabetes
Hypertension	Systolic blood pressure > 160 mmHg, or diastolic pressure > 100 mmHg, or antihypertensive medication
Hyperlipidemia	Total cholesterol > 250 mg/dl or triglyceride level > 200 mg/dl
Smoking	Current smoking (including patients stopped less than one year before CABG)
Family history	Family history of coronary, cerebrovascular or vascular disease
Peripheral vascular disease	Peripheral vascular pathology or operation
Neurological disease	Stroke and/or transient ischemic attack
Renal disease	Renal failure (creatinine $\geq 150 \mu\text{mol/l} - \text{mg/dl}$), preoperative dialysis, renal transplantation
Pulmonary disease	Chronic obstructive pulmonary disease and/or history of previous lung disease
Preoperative M.I.	History of myocardial infarction before the operation
Arrhythmia	Absence of sinus rhythm
Left main	Left main coronary artery stenosis > 50%
Left ventricular function	Ejection fraction: Good > 50%; Moderate > 30%, < 50%; Poor < 30%
NYHA	New York Heart Association classification
ECC	Extracorporeal circulation, duration in minutes
AoX	Aortic cross-clamp time, duration in minutes
Endarterectomy	Endarterectomy of at least one major coronary artery.
Perioperative M.I.	A new Q wave and a CK-MB $\geq 10\%$ of total CK
Reintervention	Reoperation for bleeding or tamponade
Stroke	Postoperative cerebrovascular accidents and/or transient ischemic attack
Renal complications	Postoperative renal failure (creatinine $\geq 150 \mu\text{mol/l} - \text{mg/dl}$) or dialysis
Pulmonary complications	Postoperative pulmonary infection
Hospital stay	Postoperative days at the cardiac surgery center UMCN-st Radboud, Nijmegen
Hospital mortality	All cause of mortality during postoperative hospital stay at the cardiac surgery centre

history of coronary disease. The presence of neurological and pulmonary disease was not significantly different between group A and B.

Patients in group B were statistically significant younger than patients in group A and patients in group B had more peripheral ischemic arterial vascular disease and renal disease. The percentage of patients with a left main coronary artery stenosis was significantly lower in group B. The incidence of preoperative acute myocardial infarction, arrhythmia, left ventricular dysfunction, number of diseased vessels, and NYHA class did not differ significantly between group A and B.

3.2. Operative characteristics

The duration of extracorporeal circulation was obviously shorter in group B than in group A, and patients in group B had less distal anastomoses than patients in group A. The aortic cross-clamp time, the number of grafts and the incidence of endarterectomy were not significantly different between the two groups.

These operative data are outlined in Table 3.

3.3. Postoperative outcome and first year of follow-up

Postoperatively there was no significant difference, neither in percentages of arrhythmia, myocardial infarction, reintervention and neurological, renal and pulmonary complications, nor in hospital mortality and hospital stay. Follow-up results showed no significant differences in cardiac related mortality and recurrent non-fatal ischemic events.

These data are shown in Table 4.

Table 2
Patient characteristics at baseline (before CABG)

	Group A N=1141 (%)	Group B N=113 (%)	P-value
Gender			0.200
Men	836 (73.3)	89 (78.8)	
Women	305 (26.7)	24 (21.2)	
Age (yrs)	64.2±10.6	61.5±10.9	0.010
Diabetes mellitus	69 (6.1)	10 (8.8)	0.240
Hypertension	612 (53.6)	71 (62.8)	0.610
Hypertlipidemia	636 (55.7)	71 (62.8)	0.140
Smoking history	637 (55.8)	62 (54.0)	0.860
Family history of coronary disease	604 (52.9)	64 (56.6)	0.720
Peripheral vascular disease	132 (11.6)	22 (19.5)	0.015
Neurological disease	97 (8.5)	11 (9.7)	0.650
Renal disease	37 (3.2)	8 (7.1)	0.036
Pulmonary disease	92 (8.1)	11 (9.7)	0.530
Myocardial infarction	506 (44.3)	53 (46.9)	0.600
Arrhythmia	48 (4.2)	5 (4.4)	0.910
Left main coronary artery stenosis	200 (17.5)	8 (7.1)	0.004
Mean number of diseased vessels	2.5±0.7	2.4±0.4	0.080
range	1-3	1-3	
NYHA			0.24
Class I	23(2)		
Class II	108 (9)	12 (10)	
Class III	799 (70.0)	77 (70)	
Class IV	221 (19)	24 (20)	
Left ventricular function			0.890
Good	1090 (95.5)	107 (94.7)	
Moderate	36 (3.2)	4 (3.5)	
Poor	15 (1.3)	2 (1.8)	

Table 3
Operative characteristics

	Group A N= 1141 (%)	Group B N=113 (%)	P-value
ECC (minutes)	79.9±38.7	72.0±39.3	0.039
AoX (minutes)	43.0±25.8	38.3±25.4	0.063
Number of grafts	2.0±0.9 (1-3)	1.9±0.2 (1-3)	0.150
Number of distal anastomoses	3.2±1.3 (1-5)	2.2±0.9 (1-6)	0.001
Endarterectomy	35 (3.1)	1 (0.9)	0.180

3.4. Multivariate logistic regression analysis

The results of multivariate logistic regression analysis were presented in Table 5. Important is that PCI is not identified as independent variable for hospital-, cardiac related mortality, and recurrent non-fatal ischemic events at one year postoperative.

For hospital mortality, age, pulmonary disease, left main, NYHA, left ventricular function, perioperative myocardial infarction, reintervention, renal complications and stroke were identified as independent variables as expected. For one-year cardiac related mortality only the number of diseased vessels disease were identified. For non-fatal ischemic events during the first postoperative year, pulmonary disease, preoperative myocardial infarction and postoperative arrhythmia were identified.

4. Discussion

Since the introduction of percutaneous coronary intervention an increasing number of patients undergoing isolated coronary artery bypass surgery have had previously successful PCI. The differences between this patient-population and patients treated primary by CABG as the therapy for coronary artery disease have hardly been studied [7,8], while many reports have been published about the comparison of outcomes of primary CABG and primary PCI [1-3] and about the differences between patients treated by PCI and patients initially treated by PCI later requiring CABG [9,10]. Other reports described the changing population being offered primary CABG [4-6].

Here, we present a large study on the preoperative, peroperative and postoperative differences between patients treated primary by CABG and patients initially treated by PCI and later required CABG. We used these data from our database (CORRAD) to assess the difference in operative risk between both groups. Patients undergoing an emergency-CABG with or without a failed PCI and patients who had undergone PCI unsuccessfully were not included. This was appropriate because patients undergoing emergency-CABG are in any case at higher risk because of their myocardial ischemia, and patients who had undergone unsuccessful PCI do not belong to our target group.

Patients with previous PCI were three years younger and had more peripheral arterial and renal disease. This may point to a more aggressive form of atherosclerosis. In both groups the percentages of diabetes mellitus, hypertension, hyperlipidemia, smoking history and family history of coronary disease as risk factors for ischemic heart disease

Table 4
Postoperative outcome and first year of follow-up

	Group A N=1141 (%)	Group B N=113 (%)	P-value
Arrhythmias	78 (6.8)	6 (5.3)	0.53
Myocardial infarction	68 (6.0)	10 (8.8)	0.22
Reintervention	14 (1.2)	2 (1.8)	0.81
Stroke	20 (1.8)	3 (2.7)	0.49
Renal complications	66 (5.8)	10 (8.8)	0.19
Pulmonary complications	89 (7.8)	12 (10.6)	0.29
Hospital mortality	24 (2.1)	4 (3.5)	0.32
Hospital stay (days)			0.41
Mean ± SD	8.3 ± 9.4	8.2 ± 9.0	
Median	6	6	
Range	0-123	0-94	
Follow-up	N=1117 (%)	N=109 (%)	
Recurrent non-fatal event	55 (4.9)	8 (7.3)	0.27
Cardiac related mortality	13 (1.2)	0	0.25
Lost to follow-up	1	0	

were similar. So, patients who had undergone previously successful PCI and needed CABG were smoking as much as patients who needed to be treated by primary CABG. This underlines again the difficulty for patients to quit smoking, even if they have a motive in the past [11].

The percentage of patients with a left main coronary artery stenosis was significantly lower in patients with a previous PCI, which was expected because patients with a left main coronary artery stenosis have the preference in our centre to be treated by CABG rather than PCI. The number of diseased vessels was not significantly different between both groups, but we have no clear explanation why the duration of extracorporeal circulation was obvi-

Table 5
Multiple logistic regression analysis for adverse outcomes

Variable	Hospital mortality		One-year cardiac related mortality		Non-fatal recurrent events	
	P-value	Odds	P-value	Odds	P-value	Odds
PCI	0.41	1.02	0.31	1.03	0.34	1.03
Gender	0.37	1.02	0.46	1.02	0.10	1.04
Age	0.00	1.07	0.92	1.00	0.11	1.05
Diabetes	0.71	1.04	0.96	1.00	0.62	1.01
Hypertension	0.73	1.00	0.25	1.03	0.67	1.01
Hyperlipidemia	0.96	1.00	0.06	1.05	0.07	1.06
Peripheral vascular disease	0.06	1.04	0.41	1.02	0.85	1.00
Neurological disease	0.69	1.01	0.20	1.04	0.92	1.00
Renal disease	0.18	1.03	0.81	1.00	0.68	1.01
Pulmonary disease	0.03	1.05	0.31	1.03	0.02	1.07
Preoperative M.I.	0.91	1.00	0.15	1.04	0.00	1.14
Arrhythmia	0.84	1.00	0.37	1.03	0.63	1.01
Diseased vessels	0.71	1.00	0.04	1.05	0.37	1.02
Left main	0.006	1.07	0.27	1.03	0.41	1.02
NYHA	0.04	1.05	0.98	1.01	0.66	1.01
Left ventricular function	0.00	1.11	0.68	1.12	0.08	1.05
Postoperative arrhythmia	0.48	1.02	0.60	1.01	0.01	1.08
Perioperative M.I.	0.00	1.12	0.82	1.00	0.37	1.02
Reintervention	0.00	1.09	0.80	1.00	0.96	1.00
Renal complications	0.00	1.11	0.39	1.03	0.68	1.01
Stroke	0.00	1.34	0.53	1.02	0.13	1.04
Pulmonary complications	0.34	1.02	0.53	1.02	0.40	1.02

P=0.00 means $P \leq 0.001$

ously shorter in patients with previous PCI. Although there was a lower number of distal anastomoses, but this was not reflected in a shorter aortic cross clamp time. The number of grafts was not different, so that performing more proximal anastomoses, during reperfusion, is not the argument for a longer perfusion time. Although the degree of vessel disease was not different in both groups, the significantly higher number of distal anastomoses and the higher percentage of endarterectomies in patients without previous PCI suggests a more extended form of atherosclerosis in this group, probably a reason for a longer reperfusion time after cross-clamp removal. The lower number of distal anastomoses suggests also a good result of the previous PCI.

Postoperatively, there was no difference in complications and the follow-up results did not show differences in cardiac related mortality and recurrent non-fatal ischemic events.

Multivariate stepwise regression analysis confirmed that a previous PCI did not predispose to mortality and recurrent non-fatal ischemic events after CABG. So, there is no indication that a previous successful PTCA results in a higher postoperative mortality or morbidity or poorer results after primary CABG. Interesting in our multivariate analysis is the identification of age, pulmonary disease, preoperative myocardial infarction, diseased vessels, left main, NYHA, left ventricular function, reintervention, postoperative arrhythmia, perioperative myocardial infarction, renal complications and stroke as independent risk factors for an impaired outcome. Most of these variables were also identified in other risk-analysis for mortality and return of ischemic events after CABG [12].

There are several limitations in our study. The most important is the absence of cardiac data, as vessel disease, ejection fraction, NYHA-class, event-free period, of group B at the moment of the PCI. As already mentioned in this discussion, we can suggest a more extended form of atherosclerosis in group A and we suggest a good result of the previous PCI. It would be nice if we could retrieve all pre-PCI cardiac data. However, several of these patients had their PCI at another cardiac center, and several of them in an acute situation, so that only a few of the representative data were available. Another weakness may be that most of the studied patients were operated on between 1999 and 2001, and were not stented during their PTCA before the operation. However, this still reflects current practice in 2004.

In conclusion, our study suggests, in contrast with other studies [9,10], that there is no indication that a previously successful PTCA result in a higher postoperative mortality or morbidity or poorer results after CABG. Therefore, patients with previous successful PCI, who have recurrent angina, may be good candidates for primary CABG.

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