Impact of prior percutaneous coronary intervention on the outcome of coronary artery bypass surgery: A multicenter analysis

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Objectives: Do prior percutaneous coronary interventions adversely affect the outcome of subsequent coronary artery bypass grafting? We investigated this effect on a multicenter basis.

Methods: Eight cardiac surgical centers provided outcome data of 37,140 consecutive patients who underwent isolated first-time coronary bypass grafting between January 2000 and December 2005. Twenty-two patient characteristics and outcome variables were retrieved. Three groups of patients were analysed for in-hospital mortality and in-hospital major adverse cardiac events: patients without a previous percutaneous coronary intervention, with 1 previous intervention, and with 2 or more previous percutaneous coronary interventions before bypass grafting. A total of 29,928 patients with complete information for prior percutaneous coronary intervention underwent final analysis. Unadjusted univariate and risk-adjusted multivariate logistic regression analysis as well as computed propensity score matching were performed, based on 14 major risk factors to correct for and minimize selection bias.

Results: A total of 10.3% of patients had 1 previous percutaneous coronary intervention, and 3.7% of patients had 2 or more previous interventions. Risk-adjusted multivariate logistic regression analysis revealed a significant association of 2 or more previous percutaneous coronary interventions with in-hospital mortality (odds ratio [OR], 2.0; confidence interval [CI], 1.4–3.0; $P = .0005$) and major adverse cardiac events (OR, 1.5; CI, 1.2–1.9; $P = .0013$). After propensity score matching, conditional logistic regression analysis confirmed the results of adjusted analysis. A history of 2 or more previous percutaneous coronary interventions was significantly associated with in-hospital mortality (OR, 1.9; CI, 1.3–2.7; $P = .0016$) and major adverse cardiac events (OR, 1.5; CI, 1.2–1.9; $P = .0019$).

Conclusions: Multicenter analysis confirms that a history of multiple previous percutaneous coronary interventions increases in-hospital mortality and the incidence of major adverse cardiac events after subsequent coronary artery bypass grafting. Critical discussion of the treatment strategy in these patients is warranted.

Worldwide, the number of coronary artery bypass grafting (CABG) procedures performed per year reached a maximum in the late 1990s and has declined since then by 20%.[1] In contrast, the number of percutaneous coronary interventions (PCIs) performed per year keeps on growing exponentially worldwide.[2] Accordingly, the number of patients requiring CABG who have a history of previous PCI procedures rises.

Evidence from randomized trials[3,4] and from large registries[5-7] has proven that, concerning 3-vessel disease, CABG is a more effective treatment than PCI, not only in terms of freedom from recurrent angina and reintervention, but also in terms of survival and freedom from major adverse cardiac events (MACEs).

Just as important as the choice of therapy for patients with coronary artery disease is the question of how one of the respective therapies (CABG or PCI) may be influenced by the

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Abbreviations and Acronyms

CABG = coronary artery bypass grafting
CI = confidence intervals
COPD = chronic obstructive pulmonary disease
LVEF = left ventricular ejection fraction
MACE = major adverse cardiac event
MI = myocardial infarction
OR = odds ratio
PCI = percutaneous coronary intervention

other. CABG after prior PCI might not achieve the same excellent results. Patients with initial percutaneous transluminal coronary angioplasty, who subsequently underwent CABG, had a poorer long-term survival than those without angioplasty.[8] There is also evidence that PCI itself adversely affects the outcome after repeated PCI.[9] Recent single center study data indicated that patients with 2 or more prior PCIs have a significantly higher in-hospital mortality and MACE rate when they subsequently undergo CABG.[10] In the subgroup of patients with multivessel disease and diabetes mellitus, 1 previous PCI procedure before subsequent CABG was associated with an increase in-hospital mortality and MACE rate.[11] Moreover, recent data indicate that long-term outcomes and quality of life are impaired after CABG with prior PCI[12] and that the rates of unstable angina requiring hospitalization and the rates of repeated coronary revascularization during follow-up are increased in CABG patients with prior PCI.[13]

The present study was performed to compare early outcome after CABG with and without prior PCI on a multicenter basis.

METHODS

Study Design

The study was a retrospective, multicenter, cohort study. Eight cardiac surgical centers in North Rhine–Westphalia, the largest federal state in Germany, participated. A total of 37,140 consecutive patients undergoing first time isolated CABG between January 2000 and December 2005 were included and assigned to groups as follows: group 1, no previous PCI; group 2, one single previous PCI; or group 3, multiple repeated (≥2) PCIs before CABG. Single or multiple PCIs applies to episodes or sessions. This implies that, in one session, more than one vessel may have been subjected to intervention. Reoperative and concomitant cardiac surgical procedures were excluded. The study was approved by the institutional review boards of the participating centers. All patients gave permission for the use of their medical records for research purposes.

Data Collection

For each patient, 22 parameters were retrieved. Among them, 18 patients and surgery characteristics (age, sex, obesity with a body mass index > 30, left main stem disease, left ventricular ejection fraction [LVEF], peripheral vascular disease , chronic obstructive pulmonary disease [COPD], diabetes mellitus, hypertension, ever smoking, hyperlipidemia, previous myocardial infarction (MI), emergency, elective surgery, number of grafts, history of PCI, number of prior PCI procedures, year of surgery), and four major event categories (in-hospital death and in-hospital MACEs, the latter being defined as perioperative MI, low cardiac output syndrome, or cardiac death). In most cases, PCI consisted of a combination of coronary stenting and coronary balloon angioplasty. In a not further defined small number of cases, percutaneous transluminal coronary angioplasty may have been the only procedure preformed. In addition, other procedures such as coronary atherectomy, coronary ablation therapy, and coronary brachytherapy may have been performed. The dates of PCI procedures were not defined.

TABLE 1. Baseline characteristics of the patients

Characteristic	No previous PCI group	1 PCI group	≥2 PCI group	*P* value
No. of patients	25,752	3,078	1,098	
Age (y)	66.40 ± 9.27	65.45 ± 9.45	65.31 ± 9.56	<.0001
Female sex (%)	26.96	26.26	26.25	.64
Obesity (%)	25.35	27.91	26.47	.0076
Left main stem disease (%)	24.65	23.70	28.53	.0062
LVEF				
<30% (%)	8.93	12.31	9.89	
30–50% (%)	25.43	27.06	24.89	<.0001
>50% (%)	65.65	60.63	65.21	
PVD (%)	15.21	16.98	20.43	<.0001
COPD (%)	9.86	8.03	10.97	.0019
Diabetes mellitus (%)	27.55	29.51	28.90	.052
Hypertension (%)	83.75	88.07	90.36	<.0001
Ever smoking (%)	44.97	47.50	53.51	<.0001
Hyperlipidemia (%)	74.50	80.15	84.61	<.0001
Previous MI (%)	36.57	61.19	58.77	<.0001
Emergency (%)	6.12	7.67	7.47	.0011
No. grafts	2.82 ± 0.90	2.55 ± 0.84	2.59 ± 0.90	<.0001
Year of operation				
2000 (%)	5.35	1.98	4.55	
2001 (%)	6.46	1.79	5.10	
2002 (%)	24.96	24.50	20.13	
2003 (%)	21.43	25.34	20.13	<.0001
2004 (%)	21.47	23.33	28.14	
2005 (%)	20.33	23.07	21.95	

PCI, Percutaneous coronary intervention; *LVEF,* left ventricular ejection fraction; *PVD,* peripheral vascular disease; *COPD,* chronic obstructive pulmonary disease; *MI,* myocardial infarction. Data were presented as proportion or mean ± SD. Year of surgery denotes the percentage of patients of any one of the three groups, operated on in the indicated year. Kruskal–Wallis test was used for continuous variables, χ^2 test and Cochran–Armitage test were used for proportions. *P* value indicates maximum significance level between any of the three groups.

Outcome Measures and Definitions

The primary end point was in-hospital mortality after CABG. The secondary end point was the rate of MACEs. Previous MI was considered to have occurred when one of the following criteria were present: (1) new persistent ST-segment or T-wave changes, (2) the development of new Q waves, (3) a creatine kinase level more than 3 times above the upper reference level, or (4) a cardiac troponin I level greater than 10.5 ng/mL. Low cardiac output syndrome was assumed to exist in patients who had a cardiac index less than 2.0 $L \cdot min^{-1} \cdot m^{-2}$ or a systolic arterial pressure less than 90 mm Hg, despite high-dose inotropic support (intravenous dopamine $\geq 8\ \mu g \cdot kg^{-1} \cdot min^{-1}$, dobutamine $\geq 6\ \mu g \cdot kg^{-1} \cdot min^{-1}$, epinephrine > $0.1\ \mu g \cdot kg^{-1} \cdot min^{-1}$, or norepinephrine > $0.1\ \mu g \cdot kg^{-1} \cdot min^{-1}$). Death was considered cardiac in origin if it was caused by previous MI, significant cardiac arrhythmias, refractory low cardiac output syndrome, or if it was otherwise unexplained.