

PCI Versus CABG in Patients With Type 1 Diabetes and Multivessel Disease

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ABSTRACT

BACKGROUND It is unknown if coronary artery bypass grafting (CABG) or percutaneous coronary intervention (PCI) may offer a survival benefit in patients with type 1 diabetes (T1D) in need of multivessel revascularization.

OBJECTIVES This study sought to determine if patients with T1D and multivessel disease may benefit from CABG compared with PCI.

METHODS In an observational cohort study, the authors included all patients with T1D who underwent a first multivessel revascularization in Sweden from 1995 to 2013. The authors used the SWEDEHEART (Swedish Web-system for Enhancement and Development of Evidence-based care in Heart disease Evaluated According to Recommended Therapies) register, the Swedish National Diabetes Register, and the Swedish National Patient Register to retrieve information about patient characteristics and outcomes. They estimated hazard ratios (HRs) adjusted for confounders with 95% confidence intervals (CIs) for all-cause and coronary heart disease mortality, myocardial infarction, repeat revascularization, stroke, and heart failure using inverse probability of treatment weighting based on propensity scores.

RESULTS In total, 683 patients who underwent CABG and 1,863 patients who underwent PCI were included. During a mean follow-up of 10.6 years, 53% of patients in the CABG group and 45% in the PCI group died. PCI, compared with CABG, was associated with a similar risk of all-cause mortality (HR: 1.14; 95% CI: 0.99 to 1.32), but higher risks of death from coronary heart disease (HR: 1.45; 95% CI: 1.21 to 1.74), myocardial infarction (HR: 1.47; 95% CI: 1.23 to 1.78), and repeat revascularization (HR: 5.64; 95% CI: 4.67 to 6.82). No differences in risks of stroke or heart failure were found.

CONCLUSIONS Notwithstanding the inclusion of patients with T1D who might not have been able to undergo CABG in the PCI group we found that PCI, compared with CABG, was associated with higher rates and risks of coronary heart disease mortality, myocardial infarction, and repeat revascularizations. Our findings indicate that CABG may be the preferred strategy in patients with T1D in need of multivessel revascularization. (J Am Coll Cardiol 2017;■:■-■)
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Among patients who undergo multivessel revascularization with coronary artery bypass grafting (CABG), or percutaneous coronary intervention (PCI), 25% have diabetes. A mortality benefit favoring CABG over PCI has been

proven for patients with diabetes. In the BARI (Bypass Angioplasty Revascularization Investigation) study, patients with diabetes who underwent PCI had almost double the 5-year mortality of those who underwent CABG (1). Later, the FREEDOM

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**ABBREVIATIONS
AND ACRONYMS****CABG** = coronary artery bypass grafting**CI** = confidence interval**HR** = hazard ratio**PCI** = percutaneous coronary intervention**T1D** = type 1 diabetes**T2D** = type 2 diabetes

(Future REvascularization Evaluation in patients with Diabetes Mellitus) study, where 1,900 patients with diabetes and multivessel disease were randomized to undergo either PCI or CABG, demonstrated a reduction in the composite outcome of death from any cause, nonfatal myocardial infarction, or nonfatal stroke in favor of CABG over PCI (2). Similarly, in a subgroup analysis of 452 patients with diabetes who were randomized to either PCI or CABG in the SYNTAX (Syn-

ergy Between Percutaneous Coronary Intervention With TAXUS and Cardiac Surgery) trial, a survival benefit was found for patients treated with CABG (3). For this reason, current guidelines support CABG over PCI as the preferred treatment of multivessel disease in patients with diabetes (4,5).

None of the abovementioned studies reported the proportion of patients with type 1 diabetes (T1D) included. However, type of diabetes may also be of great importance because the long-term prognosis after CABG is dire in patients with T1D (6), compared with patients with type 2 diabetes (T2D) whose long-term prognosis is similar to that of patients without diabetes (3,6). The reason for the poor prognosis in patients with T1D after CABG is not fully understood; however, factors such as diabetes duration and glyce-mic control may be of great importance (7). Therefore, the recommendation that all diabetes patients in need of multivessel revascularization should undergo CABG cannot easily be translated to patients with T1D.

Thus, it is unknown whether patients with T1D have the same benefit as patients with T2D from CABG compared with PCI. Therefore, we performed a nationwide, population-based cohort study in all patients with T1D who underwent a first multivessel revascularization with either CABG or PCI over a period of 19 years in Sweden.

METHODS

DATA SOURCES AND STUDY POPULATION. The study database was created by using the unique personal identity number assigned to every Swedish resident as the identifier to crosslink a number of Swedish national health care registries. The records linkage procedure was performed at the Swedish National Board of Health and Welfare, which anonymized the database before it was returned to the research group.

All patients with T1D who underwent a first isolated multivessel (defined as involving at least 2 significantly stenosed coronary arteries) cardiac revascularization with PCI or isolated CABG from 1995 to 2013 in Sweden were included. Exclusion criteria were prior

cardiothoracic surgery; prior or current left main coronary artery revascularization; emergency procedure; valvular heart surgery or vascular surgery concurrently with CABG, or PCI for ST-segment elevation myocardial infarction; prior single-vessel PCI in the PCI group; and T1D diagnosed after the index date. The study population was identified and baseline characteristics obtained from the SWEDEHEART (Swedish Web-system for Enhancement and Development of Evidence-based care in Heart disease Evaluated According to Recommended Therapies) register (8) and the NDR (Swedish National Diabetes Register) register (9), and further expanded with information about comorbidities and outcomes from the National Patient Register (10), date and cause of death from the Cause-of-Death register, and socioeconomic data from Statistics Sweden. Data sources are described in detail in the [Online Appendix](#). How data from different sources was retrieved is described in [Online Figure 1](#).

DEFINITION OF T1D. Data from all patients with T1D, according to either an epidemiological or clinical definition, were obtained from the NDR register ([Online Appendix](#)). The epidemiological definition of T1D was onset of diabetes before the age of 30 years and treatment with insulin only (9). The clinical definition of T1D in the NDR register was decided at an outpatient visit, normally to an endocrinologist, and registered in the NDR register. The coverage of T1D patients in the NDR register is virtually complete for the whole country of Sweden (9).

FOLLOW-UP AND OUTCOMES. The primary outcome was all-cause mortality, and secondary outcomes were death from coronary heart disease, myocardial infarction, stroke, and repeat revascularization. Follow-up started when the first multivessel PCI or CABG was performed for all-cause mortality, and stroke. For repeat revascularization follow-up started at 8 days after revascularization, and for myocardial infarction, and heart failure 31 days after revascularization. Follow-up ended for all outcomes when the patient died, was hospitalized for each outcome, or on December 31, 2014. Data on rehospitalizations for myocardial infarction, heart failure, stroke, or repeat revascularization was obtained from the National Patient Register or the SWEDEHEART register. International Classification of Diseases codes for the outcome measures and comorbidities are shown in [Online Table 1](#).

STATISTICAL ANALYSIS. Missing baseline values were imputed using multiple chained equations imputation, as implemented in the MICE package in R, version 3.3.2 (R Foundation for Statistical Computing, Vienna, Austria), creating 10 imputed datasets. The percentage

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