Comparative effectiveness of coronary artery bypass grafting versus percutaneous coronary intervention in a real-world Surgical Treatment for Ischemic Heart Failure trial population

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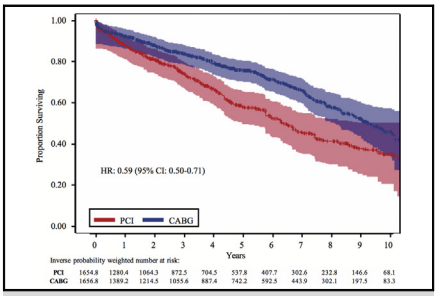
ABSTRACT

Objective: There are no prospective randomized trial data to guide decisions on optimal revascularization strategies for patients with multivessel coronary artery disease and reduced ejection fraction. In this analysis, we describe the comparative effectiveness of coronary artery bypass grafting (CABG) versus percutaneous coronary intervention (PCI) in this patient population.

Methods: A multicenter, retrospective analysis of all CABG (n = 18,292) and PCIs (n = 55,438) performed from 2004 to 2014 among 7 medical centers reporting to the Northern New England Cardiovascular Disease Study Group. After applying inclusion and exclusion criteria from the Surgical Treatment for Ischemic Heart Failure trial, there were 955 CABG and 718 PCI patients with an ejection fraction $\leq$ 35% and 2- or 3-vessel disease. Inverse probability weighting was used for risk adjustment. The primary end point was all-cause mortality. Secondary end points included rates of 30-day mortality, stroke, acute kidney injury, and incidence of repeat revascularization.

Results: The median duration of follow-up was 4.3 years (range, 1.59-6.71 years). CABG was associated with improved long-term survival compared with PCI after risk adjustment (hazard ratio, 0.59; 95% confidence interval, 0.50-0.71; $P < .01$). Although CABG and PCI had similar 30-day mortality rates ($P = .14$), CABG was associated with a higher frequency of stroke ($P < .001$) and acute kidney injury ($P < .001$), whereas PCI was associated with a higher incidence of repeat revascularization ($P < .001$).

Conclusions: Among patients with reduced ejection fraction and multivessel disease, CABG was associated with improved long-term survival compared with PCI. CABG should be strongly considered in patients with ischemic cardiomyopathy and multivessel coronary disease. (J Thorac Cardiovasc Surg 2018;■:1-12)



Kaplan-Meier survival curve of CABG versus PCI after inverse probability weighting.

Central Message

Among patients with multivessel coronary artery disease and impaired ventricular function, CABG was associated with improved long-term survival when compared with PCI.

Perspective

Data on optimal revascularization for patients with ischemic cardiomyopathy are lacking. Among this population, CABG resulted in superior long-term survival and freedom from repeat revascularization with similar 30-day mortality, but higher rates of stroke and acute kidney injury compared with PCI. CABG should be strongly considered in patients with multivessel disease and impaired ventricular function.

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Abbreviations and Acronyms

CABG = coronary artery bypass grafting
EF = ejection fraction
NNECDSG = Northern New England Cardiovascular Disease Study Group
PCI = percutaneous coronary intervention
STICH = Surgical Treatment for Ischemic Heart Failure

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In the United States, the prevalence of heart failure is projected to increase by 46% from 2012 to 2030, resulting in more than 8 million individuals diagnosed with heart failure.[1] With coronary artery disease continuing to serve as the most common etiology for heart failure, understanding the role of surgical revascularization in the spectrum of treatment options for patients with impaired ventricular function is critical.[2] As a result, in 2002, the National Institutes of Health sponsored the Surgical Treatment for Ischemic Heart Failure (STICH) trial.[3]

In arm 1 of the STICH trial, a total of 1212 patients with an ejection fraction (EF) $\leq$ 35% and coronary artery disease amenable to coronary artery bypass grafting (CABG) were randomized to optimal medical management or medical management plus CABG. At a median follow-up of 56 months, there was no significant difference between groups in the primary end point of death from any cause.[4] Although CABG was favored in the secondary end points of rate of death from cardiovascular causes and rate of death from any cause or hospitalization for cardiovascular causes, the results of STICH raised questions about the appropriateness of surgical revascularization in patients with reduced EF.[5]

In 2016, the STICH Extension Study, which examined the long-term outcomes of patients in the CABG versus optimal medical management arm of the STICH trial, was published.[6] The results demonstrated that at 10 years there was a significant reduction in the primary end point of death from any cause by 16% in favor of CABG.[6] Additionally, the secondary end points of death from cardiovascular causes and death from any cause or hospitalization were significantly lower among patients undergoing CABG. Although the results of this trial clearly demonstrated a benefit of CABG on long-term survival, reduced EF remains a significant risk factor for mortality after CABG in most risk models.[7,8] Because percutaneous coronary intervention (PCI) has become an established treatment option for select patients with coronary artery disease and the STICH trial did not include a PCI arm, we sought to assess the comparative effectiveness of CABG versus PCI among patients with reduced ventricular function and multivessel coronary artery disease.

METHODS

Data Source

The Northern New England Cardiovascular Disease Study Group (NNECDSG) is a voluntary regional consortium of 7 hospitals in New Hampshire, Vermont, and Maine that provide the majority of PCI and cardiac surgery in the region. The NNECDSG was established in 1987 for quality improvement. Its registries are prospectively maintained and validated every 2 years against hospital administrative databases to ensure complete capture of all procedures as well as to ensure that vital status at discharge has been accurately coded. The institutional review boards at 6 of the 7 centers have designated the NNECDSG registry as a quality improvement registry, and thus patient consent was waived. The remaining center obtained patient consent.

Patients

We examined all patients undergoing primary isolated coronary revascularization from 2004 to 2014 in the CABG (n = 18,292) and PCI (n = 55,438) registries. To simulate a real-world STICH-like population, the inclusion and exclusion criteria for the STICH trial were applied. The inclusion and exclusion criteria for STICH have been described previously.[3] Specifically, patients were included in the analysis who had an EF $\leq$ 35% and 2- or 3-vessel coronary artery disease. Patients were excluded who had prior PCI, CABG, or valve surgery, were of emergent status, were in cardiogenic shock, were being treated for an ST-elevation myocardial infarction, were within 24 hours of a myocardial infarction, had left main stenosis $\geq$ 50%, had single-vessel disease, or missing EF information. After exclusions, we had 7787 CABG and 7718 PCI patients (Figure E1). We then excluded patients with an EF > 35%. After this exclusion, our final study cohort was 955 CABG and 718 PCI patients.

Data Collection

Data were collected on patient demographic characteristics, baseline comorbidities, cardiac function, coronary anatomy, completeness of revascularization, in-hospital morbidity, 30-day mortality, and long-term survival. For completeness of revascularization, a ratio variable comparing the number of distal anastomoses to the number of diseased vessels was generated to serve as a proxy for completeness of revascularization. A ratio < 1.0, for example, indicates that fewer anastomoses were done than the number of diseased vessels. For long-term mortality, registry data are linked to the Social Security Administration Death Master File. Death data are no longer complete as of 2011; to supplement we obtained data from states of New Hampshire, Vermont, and Maine. Data are collected by trained data abstractors and reviewed by NNECDSG analysts and the data manager for completeness before adding data to the registry. For key demographic variables, the centers are asked to collect missing data from the medical record. The NNECDSG registry is also completely validated every year against administrative data to ensure complete capture of all patients and complete capture of patients' discharge