Meta-analysis of minimally invasive coronary artery bypass versus drug-eluting stents for isolated left anterior descending coronary artery disease

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Objective: To compare the outcomes between minimally invasive coronary artery bypass (MINI-CAB) and drug-eluting stent (DES) implantation for isolated left anterior descending artery disease.

Methods: Randomized and observational comparative publications were identified using MEDLINE and Google Scholar databases (January 2003 to December 2013). Studies without outcomes data, without DES use, or using conventional bypass surgery were excluded. The outcomes of interest were cardiac death, myocardial infarction, target vessel revascularization, and periprocedural stroke. Data were compared using the Mantel-Haenszel methods and are presented as odds ratios (ORs), 95% confidence intervals (CIs), and number needed to treat.

Results: From 230 publications, we identified 4 studies (2 randomized and 2 observational) with 941 patients (478 had undergone MINI-CAB and 463 DES implantation). The incidence of target vessel revascularization at maximum follow-up (range, 6-60 months) was significantly lower in the MINI-CAB group (OR, 0.16; 95% CI, 0.08-0.30; $P < .0001$; number needed to treat, 13). The incidence of cardiac mortality and MI was similar between the MINI-CAB and DES groups during follow-up (OR, 1.05; 95% CI, 0.44-2.47; and OR, 0.83; 95% CI, 0.43-1.58, respectively). In addition, a similar incidence of periprocedural death (OR, 0.85; 95% CI, 0.21-3.47; $P = .82$), myocardial infarction (OR, 0.98; 95% CI, 0.38-2.58; $P = .97$), and stroke (OR, 1.36; 95% CI, 0.28-6.70; $P = .70$) was observed between the 2 treatment modalities.

Conclusions: Given the available evidence, MINI-CAB will result in lower target vessel revascularization rates but otherwise similar clinical outcomes compared with DESs in patients with left anterior descending artery disease. (J Thorac Cardiovasc Surg 2014;148:1837-42)

Patients who develop coronary artery disease in the left anterior descending coronary artery (LAD) will have a large amount of viable myocardium at risk and will be prone to cardiovascular events, including myocardial infarction (MI), ischemic cardiomyopathy, and sudden cardiac death.[1,2] Coronary revascularization has, therefore, been recommended to improve the symptoms and clinical outcomes of these patients. However, the optimal revascularization strategy has remained controversial.[3-5]

Coronary artery bypass grafting (CABG) when performed with the left internal mammary artery (LIMA) to LAD graft can provide excellent long-term outcomes but at the cost of an increased risk of complications compared with less invasive percutaneous coronary intervention (PCI). Randomized studies in the early era of PCI failed to match the outcomes obtained with CABG, primarily because of a greater need for repeat revascularization owing to restenosis.[6-8] However, with the introduction of drug-eluting stents (DESs) a dramatic reduction in restenosis was seen compared with bare metal stents or balloon angioplasty alone. As such, much of the long-term advantages of CABG were thought to have been eliminated.[9,10] In those settings in which the percutaneous treatment options will be equally effective, most cardiologists, as well as patients, have currently preferred PCI with DES implantation instead of CABG, primarily owing to the desire to avoid complications such as stroke and renal failure and the longer period to full recovery.[11,12] However, subsequent advances in CABG have led to minimally invasive techniques that allow LIMA to LAD grafting on the beating heart using smaller sternal-sparing incisions.[13-15] The major rationale for these techniques

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Abbreviations and Acronyms

CABG = coronary artery bypass grafting
DES = drug-eluting stent
LAD = left anterior descending artery
LIMA = left internal mammary artery
MI = myocardial infarction
MINI-CAB = minimally invasive coronary artery bypass
PCI = percutaneous coronary intervention

has been to avoid stroke or systemic embolization by avoiding crossclamping the aorta and avoiding the costs and morbidity associated with the cardiopulmonary bypass circuit.[16] We performed a meta-analysis to compare the outcomes from minimally invasive coronary artery bypass (MINI-CAB) using LIMA to LAD grafting with PCI using DESs for the management of LAD disease.

METHODS

Inclusion Criteria

To be eligible for inclusion in our meta-analysis, the studies had to have (1) compared MINI-CAB with DES for LAD revascularization and (2) reported the outcomes for ≥1 clinical outcomes (ie, death, MI, stroke, target vessel revascularization [TVR]) during the periprocedural period and at ≥6 months of follow-up.

Search Strategy

A literature search was performed using MEDLINE and Google Scholar databases on all studies published of human subjects from January 1, 2003 to December 29, 2013. We used 2003 as the starting point, because DES technology was not commercially available in most catheterization laboratories before 2003. We combined 3 searches that used the following search headings: "percutaneous coronary intervention," "PCI," or "stent" (search 1); "minimally invasive direct," "endoscopic atraumatic," "totally endoscopic," "port-access," or "coronary artery bypass" (search 2); and "left anterior descending," "LAD", or "single vessel disease" (search 3). To broaden the search, we also used the "related articles" function. All abstracts were reviewed, and no language restrictions were applied. The search resulted in 230 studies (Figure 1). After a review of the titles and abstracts, we found 20 studies that required a full text review. From these studies, we excluded those reporting on outcomes of patients with multivessel disease who had undergone multivessel revascularization (n = 1), same cohort studies with different follow-up periods (n = 1), studies using bare metal stents or balloon angioplasty (n = 12), and studies using conventional CABG with median sternotomy (n = 2). The remaining studies were included in the present meta-analysis.

Statistical Analysis

Our meta-analysis was performed in line with the recommendations from the reporting of meta-analysis guidelines for observational studies.[17] The categorical outcomes data are reported as an odds ratio (OR) statistic, in which an OR of <1 favored the surgical group. We used a random effects model with the Mantel-Haenszel method, in which it was assumed that variation existed among the studies owing to the varying risk profiles and selection criteria among the centers. The calculated OR, therefore, had a more conservative value. Heterogeneity was assessed and reported using the Cochran C statistic. Data inconsistency was reported using I^2 tests, in which a score of 25%, 50%, and 75% indicated a low, moderate, or high level of data inconsistency, respectively. To translate ORs into benefits to clinical outcome, we calculated the number needed to treat, which is the inverse of the risk difference between the 2 treatment groups. For studies that contained a 0 in the cell for the number of events of interest in either 1 of the groups, we added the value of 0.5 in each cell of the 2×2 table for the study in question. This correction was necessary, because cells with 0 events will create problems with the computation of the ratio measures and standard errors of treatment effects. Analyses were performed using Comprehensive Meta-Analysis software, version 2 (Biostat, Englewood, NJ).

RESULTS

Study Characteristics

A total of 4 studies published from 2005 to 2013 that matched the inclusion criteria for comparing MINI-CAB versus DES implantation for isolated LAD revascularization.[12,18-20] These studies had included 941 patients, of whom 51% had undergone MINI-CAB and 49% DES implantation. Both reviewers had 100% agreement on data extraction. The study designs involved 2 randomized controlled trials (n = 319) and 2 observational studies using propensity score methods to adjust for confounding (n = 622). The maximum follow-up ranged from 6 to 60 months. The characteristics of these studies are listed in Table 1.

Patient and Procedural Characteristics

An overview of the patient and procedural characteristics is listed in Table 2. The patients were, on average, in their mid-60s (range, 61-66 years) and were predominantly male (range, 64%-80%). The occurrence of diabetes ranged from 21% to 60%, and most patients had preserved left ventricular ejection fraction without a history of MI. Coronary angiography showed that the treated lesions were predominantly complex lesions, either type B2 or C. In the 2 observational studies, the total occluded LAD lesions were numerically more common than in the MINI-CAB group.[18,19] Sirolimus-eluting stents were used exclusively in 2 studies.[12,18] Overall, sirolimus-eluting stents were used in 70% of patients (n = 324) and paclitaxel-eluting stents in 30% of patients (n = 139). Surgical access was performed using a left anterolateral thoracotomy (5-8 cm) between the fourth or fifth intercostal space. In 3 studies, the ribs were retracted to allow LIMA harvesting and anastomosis to the LAD under direct vision.[12,18,20] In 1 study, the LIMA was harvested using a thoracoscopic approach, and the anastomosis was performed using endoscopic stabilization devices without rib retraction.[19] All procedures were performed without the use of cardiopulmonary bypass.

Postprocedural Outcomes

As shown in Figure 2, the postprocedural outcomes for death, MI, stroke, and TVR were infrequent and also not significantly different statistically between MINI-CAB and DES implantation. Two studies reported the postprocedural