Results of the minimally invasive coronary artery bypass grafting angiographic patency study

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Objective: Minimally invasive coronary artery bypass grafting is safe and widely applicable, and may be associated with fewer transfusions and infections, and better recovery than standard coronary artery bypass grafting. However, graft patency rates remain unknown. The Minimally Invasive Coronary Artery Bypass Grafting Patency Study prospectively evaluated angiographic graft patency 6 months after minimally invasive coronary artery bypass grafting.

Methods: In this dual-center study, 91 patients were prospectively enrolled to undergo minimally invasive coronary artery bypass grafting via a 4- to 7-cm left thoracotomy approach. The left internal thoracic artery, the ascending aorta for proximal anastomoses, and all coronary targets were directly accessed without endoscopic or robotic assistance. The study primary outcome was graft patency at 6 months, using 64-slice computed tomography angiography. Secondary outcomes included conversions to sternotomy and major adverse cardiovascular events (Clinical Trial Registration Unique identifier: NCT01334866).

Results: The mean age of patients was 64 ± 8 years, the mean ejection fraction was 51% ± 11%, and there were 10 female patients (11%) in the study. Surgeries were performed entirely off-pump in 68 patients (76%). Complete revascularization was achieved in all patients, and the median number of grafts was 3. There was no perioperative mortality, no conversion to sternotomy, and 2 reopenings for bleeding. Transfusion occurred in 24 patients (26%). The median length of hospital stay was 4 days, and all patients were followed to 6 months, with no mortality or major adverse cardiovascular events. Six-month computed tomography angiographic graft patency was 92% for all grafts and 100% for left internal thoracic artery grafts.

Conclusions: Minimally invasive coronary artery bypass grafting is safe, feasible, and associated with excellent outcomes and graft patency at 6 months post-surgery. (J Thorac Cardiovasc Surg 2014;147:203-9)

The 5-year results of the Synergy Between Percutaneous Coronary Intervention With Taxsus and Cardiac Surgery (SYNTAX) study and the findings of the Future Revascularization Evaluation in Patients With Diabetes Mellitus: Optimal Management of Multivessel Disease (FREEDOM) trial have recently confirmed that coronary artery bypass grafting (CABG) is the safest and most effective way to achieve myocardial revascularization in patients with triple-vessel coronary artery disease (CAD)[1] and in diabetic patients with multivessel CAD.[2,3] In addition, a significant number of patients have single-vessel CAD, most often involving the proximal left anterior descending (LAD) artery, for whom CABG is indicated because of the failure or inability to perform percutaneous coronary intervention or as a result of patient or cardiologist preference.[4,5]

Although CABG is safe and effective, its invasiveness has not appreciably diminished over the last several decades. The majority of CABG operations still involve a median sternotomy and use cardiopulmonary bypass, aortic crossclamping, and cardioplegia to induce cardiac arrest.

Safe, reproducible, and widely applicable ways to perform CABG in a less-invasive manner must be explored and investigated to safely build on the effectiveness of CABG, while decreasing its physical and psychologic trauma. To this end, we have introduced, and developed with wide applicability, minimally invasive cardiac surgery (MICS) CABG. Previous reports from our groups have demonstrated (1) the safety and feasibility of this operation in large numbers[6,7]; (2) the reproducibility of performing proximal anastomoses onto the ascending aorta[8,9]; and

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Abbreviations and Acronyms

CABG = coronary artery bypass grafting
CAD = coronary artery disease
CCS = Canadian Cardiovascular Society
CTA = computed tomography angiography
LAD = left anterior descending
LITA = left internal thoracic artery
MICS = minimally invasive cardiac surgery
MIDCAB = minimally invasive direct coronary artery bypass
SVG = saphenous vein graft

(3) the advantages of MICS CABG over sternotomy CABG in terms of lesser transfusion of blood products, decreased incidence of chest wound infection, and improved postoperative physical recovery.[10]

Nevertheless, the graft patency results of MICS CABG have so far been largely unknown. Although patency after regular CABG can be high,[11] possible concerns specific to the MICS CABG operation include its increased technical difficulty, the narrower exposure requiring more precise control of the needle during anastomosis, a more restricted selection of distal target sites, and a less intuitive assessment of optimal graft length, all of which could negatively affect graft patency rates.

Consequently, we designed this prospective cohort study in which patients scheduled to receive MICS CABG by 1 of 2 experienced MICS CABG surgeons were enrolled to undergo operation and followed for 6 months after operation, and subsequently undergo computed tomography angiography (CTA) assessment of the patency of their grafts.

MATERIALS AND METHODS

Study Objectives

The primary objective was to characterize technical success (graft patency of each graft at 6 months) and procedural success in consented patients scheduled to undergo a MICS CABG operation. The secondary objective was the evaluation of major adverse events, defined as major hemorrhage/bleeding requiring surgical intervention, aortic complications, graft vessel revision or subsequent revascularization, transient ischemic attack, cerebrovascular accident, myocardial infarction, or death, at both 30 days and 6 months after MICS CABG.

Study Design and Inclusion/Exclusion Criteria

The study was a prospective, consecutive patient enrollment, dual-center study. Inclusion criteria included age greater than 18 years and less than or equal to 80 years; nonemergency, first time, single or multivessel CABG suitable for MICS CABG; and left ventricular ejection fraction of more than 30%. Exclusion criteria were previous cardiac surgery; a history of renal insufficiency with creatinine greater than 2 mg/dL; peripheral or systemic active infection; life expectancy of less than 1 year because of other illness; uncontrolled acute myocardial ischemia; New York Heart Association class IV heart failure symptoms; uncontrolled diabetes mellitus or hypertension; recent cerebrovascular accident (within 90 days before operation); and female gender with childbearing potential.

Operative Procedure

The operative and technical details of the MICS CABG operation have been published.[6,8,9] Briefly, harvest of the left internal thoracic artery (LITA) over its entire usable length and cephalad to the level of the subclavian vein, saphenous vein graft (SVG), or radial artery proximal anastomoses handsewn onto the ascending aorta with a side-biting clamp using 6-0 polypropylene, and distal coronary anastomoses handsewn using 7-0 polypropylene are performed under direct vision, without endoscopic or robotic assistance, through a 4- to 7-cm incision in the left fourth or fifth intercostal space, through which a Thoratrak (Medtronic, Inc, Minneapolis, Minn) rib spreader and a Rultract Skyhook (Rultract, Cleveland, Ohio) retractor are used. If exposure during proximal or distal anastomoses is poor or the patient does not tolerate part of the procedure despite hemodynamic support, including low-dose vasopressors, femoral arterial and venous partial cardiopulmonary bypass (without aortic crossclamping) is used.

Postoperative Management and Outcomes Evaluation

Patients were treated postoperatively with medical therapy as with conventional CABG via sternotomy, including aspirin, beta-blockers, and anti-cholesterol agents. Patients undergoing MICS CABG with a radial artery graft were prescribed a dihydropyridine calcium channel blocker for 6 months. Patients were followed from enrollment to a minimum of 6 months after discharge from the hospital, and all related adverse events were captured and compiled. Because of the lack of evidence regarding its effects on graft patency,[11-13] clopidogrel use was left to preferred practice. As such, patients undergoing operation without cardiopulmonary bypass assistance in Ottawa received clopidogrel for 6 months postoperatively, whereas patients operated with pump assistance in Ottawa and all patients at Staten Island did not receive clopidogrel postoperatively.

The primary outcome of the study, graft patency at 6 months, was evaluated by using CTA. Before image acquisition, metoprolol or diltiazem (oral or intravenous) was administered if needed, targeting a heart rate of 65 beats/min or less. Patients also received nitroglycerin 0.6 to 0.8 mg sublingually. An intravenous bi-phasic timing bolus protocol (Staten Island University Hospital: 100 mL of ioversol injection 74%; OptiRay 350, Maqllinckrodt Inc, Hazelwood, Mont. University of Ottawa Heart Institute: 15 to 25 mL of iohexal; Omnipaque GE Healthcare, Princeton, NJ, with 40 mL of saline solution) was used to measure transit time. Subsequently, a tri-phasic protocol (100% contrast, 40%/60% contrast/saline solution [50 mL], and saline solution [40 mL]) was used to acquire final images. The volume and rate of contrast were adjusted according to the patient's body habitus and scan time. Prospective electrocardiogram-gated images were acquired during an inspiratory breath-hold with a Lightspeed VCT (GE Healthcare, Milwaukee, Wis) (64 × 0.625 mm slice collimation, 350 ms gantry rotation, 400-800 mA, 120 kVp). Padding duration when used was 100 to 150 ms, and all studies were centered at 75% R-R interval. Images were reconstructed using a slice thickness of 0.625 mm with an increment of 0.4 mm. Images were reviewed by an experienced coronary CTA radiologist on a workstation (AW 4.1 Advantage, GE Healthcare). In an effort to reduce radiation exposure, scan parameters such as max on mA, kVp, and z-axis coverage were monitored and adjusted by the CTA radiologist.

Interpretations were performed with axial data sets, maximum intensity projections, or curved multiplanar reconstructions (Figure 1) at the discretion of the radiologist. The degree of graft stenosis was graded and classified according to the Fitzgibbon score, as follows: