

Sternotomy Versus Nonsternotomy LIMA-LAD Grafting for Single-Vessel Disease

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Background. Single-vessel disease of the left anterior descending (LAD) coronary artery may be surgically revascularized by left internal mammary artery (LIMA) grafting either through a sternotomy or a nonsternotomy approach. Nonsternotomy approaches are used in the hope of achieving a less invasive operation. It is unknown whether nonsternotomy approaches impact in-hospital or midterm outcomes.

Methods. The institutional Society of Thoracic Surgeons (STS) database at a single US academic center was reviewed for 597 consecutive patients treated surgically for single-vessel LAD disease from January 1, 2002 to June 30, 2011. In-hospital adverse events and length of stay (LOS) were compared between patients who had LIMA-LAD grafting performed through a sternotomy (sternotomy patients) versus patients who had this procedure performed through a nonsternotomy approach (nonsternotomy patients), adjusted for propensity score (likelihood of receiving sternotomy, calculated on 33 variables). Midterm survival between groups was compared using Kaplan-Meier and Cox regression analysis by referencing the National Social Security Death Index.

Results. There were 597 consecutive patients who underwent single-vessel grafting by LIMA-LAD coronary artery grafting. Of these patients, 234 underwent sternotomy, whereas 363 patients had nonsternotomy procedures: 239 patients had endoscopic LIMA harvest and left anterolateral thoracotomy, 106 patients had robot LIMA harvest and left anterolateral thoracotomy, and 18 patients had minimally invasive direct coronary artery bypass. There were no strokes in the nonsternotomy group and 3 (1.3%) in the sternotomy group ($p = 0.031$). Thirty-day mortality, incidence of myocardial infarction, hospital LOS, and midterm survival were similar between groups. Operative time was significantly longer in the nonsternotomy group (1.8 hours, 95% confidence interval [CI], 1.5–2.1).

Conclusions. In this propensity-adjusted comparison, sternal-sparing incisions were associated with similar 30-day adverse events and midterm survival compared with sternotomy for single-vessel LIMA-LAD artery grafting.

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In the current era, coronary artery bypass grafting (CABG) is typically performed for patients with multivessel disease. However given that the survival advantage of CABG is mainly attributable to the left internal mammary artery (LIMA)-to-left anterior descending (LAD) artery graft [1], patients are still referred to cardiac surgeons for isolated proximal LAD artery disease. Traditionally this has involved a complete median sternotomy to perform the LIMA-LAD artery anastomosis, which can be performed on pump or off pump. This treatment provides the durability of the LIMA-LAD artery graft and can be accomplished with low morbidity and mortality.

As referring cardiologists and patients have sought less

invasive treatment options, there has been an increased interest in minimally invasive techniques for coronary artery bypass operations. These less invasive approaches have been applied to patients with multivessel disease but are predominantly performed for patients with isolated proximal LAD artery disease or in patients selected to undergo a hybrid revascularization approach with a LIMA-LAD artery bypass combined with percutaneous coronary intervention to non-LAD artery vessels. These alternative approaches have evolved over the past decade to include minimally invasive direct coronary artery bypass (MIDCAB), endoscopic atraumatic coronary artery bypass (EndoACAB), robotically assisted direct coronary artery bypass (RADCAB), and robotic-assisted totally endoscopic coronary artery bypass (TECAB). With the introduction of any new approach or technology, the

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Abbreviations and Acronyms

AOR	= adjusted odds ratio
CABG	= coronary artery bypass grafting
CI	= confidence intervals
EndoACAB	= endoscopic atraumatic coronary artery bypass
ICU	= intensive care unit
LAD	= left anterior descending
LIMA	= left internal mammary artery
LOS	= length of stay
MACE	= major adverse cardiac events
MIDCAB	= minimally invasive direct coronary artery bypass
RADCAB	= robotically assisted direct coronary artery bypass
STS	= Society of Thoracic Surgeons
TECAB	= robotically assisted totally endoscopic coronary artery bypass

goal is technically excellent results that are comparable to those achieved with traditional sternotomy.

Several reports comparing percutaneous coronary intervention with drug-eluting stents to MIDCAB have shown a reduced need for reintervention [2-4], and better long-term angina relief [2] with MIDCAB. However the short-term and long-term outcomes of minimally invasive approaches compared with traditional sternotomy for isolated proximal LAD artery disease are poorly defined. Therefore the purpose of this study was to compare in-hospital and midterm outcomes for sternotomy versus nonsternotomy approaches for patients undergoing single-vessel LIMA-LAD artery bypass.

Material and Methods

This study was a retrospective, single-center cohort study designed to compare 2 treatments with respect to short-term and midterm clinical outcomes. Emory University's institutional Society of Thoracic Surgeons (STS) Adult Cardiac Database was examined for all patients who underwent single-vessel CABG with LIMA-LAD artery grafting. Patients were classified as having undergone either a conventional sternotomy or a nonsternotomy approach, which at Emory included MIDCAB, EndoACAB, and RADCAB. Patients whose operations were planned as a hybrid procedure were excluded from the study because they had multivessel disease. All consecutive patients from January 1, 2002 to June 30, 2011 were analyzed, representing the entire period during which nonsternotomy approaches were performed. Patients were analyzed according to the treatment they ultimately received. This study was conducted in accordance with institutional review board approval and the Health Insurance Portability and Accountability Act. The institutional review board waived the need for individual patient consent.

Surgical Techniques

MIDCAB. This procedure involves a 5- to 8-cm anterolateral thoracotomy incision. The left lung is decompressed using a double-lumen endotracheal tube or bronchial blocker. Specialized retractors (Thoratrak, Medtronic Inc, Minneapolis, MN) elevate the anterior chest wall to facilitate harvest of the LIMA under direct vision. After harvest and pericardiotomy, the procedure can be performed off pump or with cardiopulmonary bypass support. A variety of stabilizers exist that provide a relatively motionless field during the anastomosis on the beating heart (Octopus and Octopus Nuvo, Medtronic, Inc, and ACROBAT Mechanical Stabilizer, MAQUET Cardiovascular LLC, Wayne, NJ). The anastomosis is then performed manually to the LAD artery in a manner that is technically identical to a sternotomy approach.

EndoACAB. The patient is positioned in a modified lateral decubitus position with the left side of the chest slightly elevated. A shoulder roll placed parallel to the spine just beneath the left clavicle allows the left shoulder to hang, which facilitates mobility of the most superior working port. The left arm is tucked loosely to the patient's side. A 10- to 12-mm camera port is inserted into the left side of the chest in the fourth or fifth interspace (midsternum) 2 fingerbreadths lateral to the midclavicular line or near the anterior axillary line. After insufflating the chest with carbon dioxide to 10 to 15 mm Hg, 2 5-mm operating ports are placed in a line parallel to the camera port 2 interspaces above and below the camera port under endoscopic guidance. The usual port configuration is in the second, fourth, and sixth interspaces or the third, fifth, and seventh interspaces. The LIMA can then be harvested directly using endoscopic instruments. The pericardium is also opened endoscopically. After heparinization, the LIMA is transected distally. A long spinal needle is then passed through the anterior chest wall to localize the planned site of incision. The left side of the chest is slowly deflated of carbon dioxide and the planned site of anastomosis on the LAD artery is visualized as the heart returns to its normal position within the left hemithorax. This process facilitates precise localization of the 3- to 4-cm anterolateral thoracotomy incision, usually in the fourth or fifth interspace. A soft tissue retractor (CardioVations, Edwards Lifesciences, Irvine, CA) is used to provide exposure through the interspace. The LIMA is retrieved into the operating field and prepared for anastomosis. The LAD artery target is exposed and stabilized using a minimally invasive stabilizer (Octopus NUVO, Medtronic, Inc) and the anastomosis is performed manually using fine monofilament suture.

RADCAB. This procedure is another step in the evolution of minimally invasive techniques for coronary operations. This procedure combines the technologic advances associated with robotic telemanipulation with the direct manual anastomosis associated with MIDCAB. The da Vinci Surgical System (Intuitive Surgical, Inc, Sunnyvale, CA) combines superior high-definition visualization with flexible 3-dimensional instruments to allow for complex

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