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Poor Left Ventricular Function Is Not a Contraindication for Robotic Totally Endoscopic Coronary Artery Bypass Grafting

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ABSTRACT

Robotic technology has enabled performance of totally endoscopic coronary artery bypass grafting (TECABG). Published series on TECABG were primarily performed in low-risk patients, and little is known about the outcome after totally endoscopic coronary surgery in patients with severely impaired left ventricular function. We report successful endoscopic placement of a left internal mammary artery bypass graft to the left anterior descending artery using the daVinci robotic system in a patient with a severely reduced left ventricular ejection fraction.

BACKGROUND

Totally endoscopic coronary artery bypass grafting (TECABG) is an evolving procedure. The new generation DaVinci Robotic "S" system (Intuitive Surgical, Sunnyvale, CA, USA) has made TECABG a feasible option for bypass surgery. Most series published throughout the early phase of procedure development have included low-risk patients with good ventricular function. Prolonged cardiopulmonary bypass (CPB) and aortic endoocclusion times were prohibitive for inclusion of patients with impaired left ventricular function, especially in the arrested heart version of TECABG. We present a case of a patient with a severely decreased left ventricular ejection fraction (LVEF) who underwent a left anterior mammary artery (LIMA) to left anterior descending artery (LAD) graft through TECABG on the arrested heart.

CASE REPORT

Brief Patient History

The case patient, a 46-year-old man with a history of hepatitis C, was undergoing cardiac clearance prior to inguinal hernia repair when he was noted to have significant electrocardiogram changes. A coronary angiogram demonstrated a 70% proximal LAD (with a patent large diagonal branch), a diffusely diseased circumflex system, and a totally occluded right coronary artery. There was collateralization from the left to the proximal right coronary artery. The patient subsequently underwent a cardiac perfusion scan, which demonstrated a dilated LV, an LVEF of 30%, and a proximal inferolateral fixed defect. The lateral wall was moderately viable and the anterior wall completely viable. The patient had consulted with other cardiac surgeons and cardiologists prior to his visit. He had refused conventional bypass surgery and thus was seeking consultation for TECABG. The patient was given an explanation of the risks/benefits for the procedure, and he agreed to proceed with the surgery and undergo limited revascularization.

Procedure

General anesthesia was induced by use of a double-lumen endotracheal tube. The patient was positioned with the left side elevated at 30°. Bilateral radial artery lines and defibrillator pads were inserted. A pulmonary artery catheter was inserted preoperatively. The camera port was inserted in the anterior axillary line through the fifth intercostal space; the other 2 working ports were inserted in the midclavicular line through the third and the seventh intercostal spaces, respectively. Left femoral vessels were exposed for peripheral bypass cannulation. A dual-stage venous cannula (Quick Draw; Cardiovations, Edwards Lifesciences, Irvine, CA, USA) was inserted and positioned with the tip in the superior vena cava using transesophageal echocardiography (TEE) guidance. Similarly a 23-French arterial perfusion cannula (Cardiovations) was inserted by use of TEE guidance. This procedure was followed by advancement of the endoaortic occlusion balloon. The LIMA was harvested endoscopically. The pericardial fat pad was removed. The pericardium was opened. CPB was instituted, and the patient's core temperature was cooled to 34°C. Once full CPB was instituted, the endoaortic occlusion balloon was inflated and cardiac arrest obtained by use of adenosine followed by antegrade cardioplegia infusion through the occlusion balloon system. The LAD was exposed and an arteriotomy performed with cardioplegia running. This procedure was followed by an end-to-side

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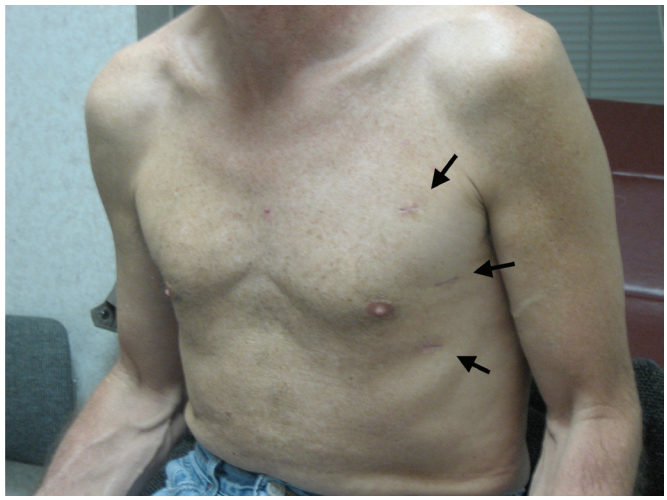
LIMA-to-LAD anastomosis performed using 7-0 Prolene. The endoaortic occlusion balloon was deflated, and sinus rhythm resumed spontaneously. The patient was weaned from CPB, and the femoral vessels were decannulated and repaired with 5-0 Prolene. During weaning from CPB, a decrease in oxygen saturation was noted and fluoroscopy demonstrated a right-sided pneumothorax, which was relieved with a chest tube on the right side. Once adequate hemostasis was confirmed, the robotic arms were removed, a chest tube was inserted through one of the port sites, and the other port sites were closed in layers. Intraoperative LIMA graft angiography was performed by the cardiologist in cooperation with the heart surgeon. The initial images demonstrated a slow runoff owing to coronary spasm. Administration of intraluminal nitroglycerin effectively released the spasm, and then good outflow was observed. The anastomosis was widely patent with runoff TIMI (thrombolysis in myocardial infarction) flow grade 3 into the proximal and distal target vessels. The catheter sheath was removed and the groin closed in layers. The patient tolerated the procedure well and was transferred to the intensive care unit in stable condition. The reduced preoperative EF of 30% on TEE showed an intraoperative increase to 46%. The Video shows the pre and postoperative echocardiogram.

Postoperative Course

The patient was weaned from inotropic support (dobutamine), extubated, and transferred to the step-down unit on postoperative day 1. He underwent aggressive physical therapy and diuresis. On postoperative day 6 the chest tubes were removed and the patient was discharged. On a clinic visit 1 month postoperatively the patient reported resuming all everyday activities and showed minimal surgical trauma (Figure).



Results 4 weeks postoperatively. The surgical trauma is minimal, with 4 ports on the chest and completely preserved sternal stability.

DISCUSSION

During the past decade, TECABG has emerged as a viable option for coronary interventions. For patients the limited scarring and decreased pain certainly make TECABG more attractive than conventional bypass surgery. The case we report of TECABG used in a patient with poor LVEF will further reinforce the notion that this method is a feasible choice in a wider range of patients undergoing coronary interventions. Theoretically patients with increased perioperative risk for conventional CABG should benefit from a less traumatic surgical approach. However, one exclusion criterion in the multicenter prospective trial of robotically assisted TECABG grafting was an EF less than 30% [Argenziano 2006]. A high mean LVEF was also reported (56% and 67.6%, respectively) in 2 other recent studies [Dogan 2002; Kappert 2008]. Similarly in one of the largest minimally invasive hybrid coronary artery revascularization series, the mean EF was 59% (±13%) [Holzhey 2008]. To our knowledge we are the first to report TECABG in a patient with severely impaired LVEF. Preoperative intraaortic balloon pump treatment in hypertensive patients with coronary artery disease, low LVEF, and LV hypertrophy who are undergoing CABG is beneficial. An improved cardiac performance pre- and postoperatively was associated with a lower rate of hospital mortality and less postoperative morbidity, as well as shorter intensive care unit stay [Christiansen 1997]. Thus preoperative intraaortic balloon pump could have been used in this procedure, and we may consider this intervention in future low EF patients undergoing TECABG. Reduced LVEF is an established risk factor in coronary surgery. A recent review of 55,515 patients from the New York State database demonstrated a >4 times mortality in patients with low EF. These patients had a higher incidence of organ dysfunction and a lower rate of hospital discharge. CABG, however, has been reported to be superior to medical management in patients with low EF, with a reported 5-year survival in patients with EF <35% of 63% in surgically treated versus 43% in medically treated patients [Topkara 2005].

Impaired LV function can pose several challenges for the robotic heart surgery team. First, a cardiomyopathic dilated LV occupies significant space inside the chest, making port placement as well as performance of the endoscopic procedure extremely challenging. Second, hearts with impaired LV function may be more likely to suffer malignant ventricular arrhythmia. Third, decompensation and the necessity for circulatory support are always possible. We therefore think that arrested heart TECABG may be the better option for these patients. CPB allows complete unloading of the dilated heart and deflation of both lungs. These procedures ensure significantly larger workspace inside the chest, an issue that was important in this case because the patient's obesity increased obstruction of the operative field. Srivastava et al [2008] in their series of beating-heart TECABG excluded 14% of patients and performed surgery through a larger thoracic incision. In the majority of these patients, hemodynamic instability, intolerance of single-lung ventilation, and arrhythmia were the causes for change of the operative strategy and conversion. These issues may be manageable with an approach using the heart-lung machine.

One issue may be tolerance of a potentially prolonged myocardial ischemic time in a totally endoscopic CABG operation on a patient with decreased LV function. A recent study has shown that endoaortic occlusion times of up to 3 hours do not lead to significant increase in myocardial enzyme release [Schachner 2007]. The endoaortic balloon occlusion time in the case we report was 94 minutes and therefore was in an acceptable range. Immediate improvement of LV function and a postoperative recovery time to full activity in the 4-week range speak for the success of the minimally invasive surgical concept chosen for this patient.

From this case we conclude that severely impaired LV function is not a contraindication for robotic TECABG. With this approach, a shorter hospital course and an attractively short time until return to normal activities can be achieved.

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