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Is an Intraaortic Balloon Pump a Contraindication to Robotic Totally Endoscopic Coronary Artery Bypass?

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ABSTRACT

Background: The success of robotic totally endoscopic coronary artery bypass (TECAB) in recent years has led to the expansion of the procedure to patients with more severe disease. Outcomes with these patients have not yet been well characterized, and no reports on TECAB performed in patients with a preoperatively placed intraaortic balloon pump (IABP) are available. We present our initial experience with this patient population.

Patients and Methods: We evaluated 5 patients with unstable angina or impaired left ventricular function requiring a preoperatively placed IABP who underwent TECAB using the daVinci telemanipulation system. Procedures were performed either on the beating heart using an endostabilizer (n = 2) or on the arrested heart using remote access perfusion and aortic balloon endoocclusion (n = 3). The median patient age was 67 years (range, 41-73 years), with a median preoperative ejection fraction of 43% (range, 26%-58%) and median EuroSCORE of 5 (range, 3-8).

Results: There were no major intraoperative technical issues. The median length of stay in the hospital and intensive care unit was 8 days (range, 5-13 days) and 66 hours (range, 41-142 hours), respectively. There were no intraoperative or 30-day mortalities.

Conclusions: This early experience suggests that TECAB is feasible in patients with a preoperatively placed IABP. Both the beating heart and arrested heart versions can be used in this patient population, further broadening the spectrum of applicability of this procedure.

INTRODUCTION

Totally endoscopic coronary artery bypass (TECAB) surgery has been shown to be safe and feasible using robotic technology [Falk 2000; Dogan 2002; Bonatti 2006; de Canière 2007]. These successes have pushed the application of this procedure to sicker patient populations, including those with a preoperatively placed intraaortic balloon pump (IABP). Outcomes with these patients have not yet been well characterized, and no reports on TECAB performed in patients with a preoperatively placed IABP are available. The presence of an IABP poses 2 significant challenges to TECAB: the degree of patient disease and, in the arrested heart version, technical difficulty with endoaortic balloon placement. We present our initial experience with patients who had preoperatively placed IABP for unstable angina or decreased ejection fraction.

PATIENTS AND METHODS

From June 2007 to December 2010, 5 patients underwent totally endoscopic coronary artery bypass grafting on the arrested (n = 3) or beating (n = 2) heart with a preoperatively

Table 1. Patient Demographics*

Age, y	60 (41-73)
Sex, % (M/F)	40/60
Height, cm	167 (157-178)
Weight, kg	85 (60-116)
Smoking, n (%)	2 (40)
Diabetes mellitus, n (%)	4 (60)
Hyperlipidemia, n (%)	5 (100)
Hypertension, n (%)	5 (100)
Chronic obstructive pulmonary artery disease, n (%)	0 (0)
Cerebrovascular disease, n (%)	1 (20)
Peripheral vascular disase, n (%)	0 (0)
Chronic renal failure, n (%)	0 (0)
Previous myocardial infarction, n (%)	3 (60)
Previous percutaneous coronary intervention, n (%)	2 (40)
Left ventricular ejection fraction, %	43 (26-58)
EuroSCORE	5 (3-8)

*Data are presented as mean (range) unless otherwise indicated.

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placed IABP. Three single-vessel, two double-vessel, and one triple-vessel bypass grafting procedures were carried out. Demographic data are shown in Table 1.

Surgical Technique

All procedures were carried out using the daVinci S or Si Robotic Systems (Intuitive Surgical, Sunnyvale, CA, USA). The patient was positioned in a 30° right lateral decubitus position. After setup of the telemanipulator, a camera port was introduced into the left fifth intercostal space on the anterior axillary line with the left lung collapsed. CO_2 was insufflated to a target pressure of 10 mmHg. Instrument ports were then inserted through the third and seventh intercostal spaces on the mamillary line using thoracoscopic vision. The internal mammary artery (IMA) was localized, and the endothoracic fascia and transverse thoracic muscle were removed from the IMA pedicle to adequately visualize the vessel. Using electrocautery at 20 watts and endoscopic clips for division of pedicle side branches, the IMA was harvested from the first to the fifth intercostal space. Heparin (300 IE/kg) was given. Then after endoscopic placement of a temporarily occluding bulldog clamp, the distal graft portion was prepared, and a free flow check was carried out.

The pericardial fat pad was then removed from the pericardium using electrocautery. After incision of the pericardium the left anterior descending artery (LAD) was identified and marked with a clip onto the adjacent epicardial fat. Care was taken to see the LAD coursing around the apex of the heart in order to avoid confusion with diagonal branches.

In arrested heart TECAB (AH-TECAB), the femoral artery and femoral vein were exposed in the left groin. The right atrium was cannulated for cardiopulmonary bypass using a 25°F or 27°F Medtronic Venous Return Cannula (96370; Medtronic, Minneapolis, MN, USA). The IABP was temporarily turned off but left in place, and a 23°F EndoReturn™ (Cardiovations; Edwards Lifesciences, Irvine, CA, USA) arterial cannula was then inserted. Cardiopulmonary bypass was initiated. The ascending aortic occlusion balloon was inflated for induction of cardioplegia. During inflation of the endoballoon the IABP was switched off.

In beating heart TECAB (BH-TECAB), patients were prophylactically cannulated for a potential heart–lung machine run. Venous cannulation was performed percutaneously through the femoral vein, and arterial cannulation was carried out through a side arm on the left axillary artery. Local target vessel immobilization in BH-TECAB was achieved using a robotic endostabilizer on the fourth arm of the robotic system and the coronary artery was locally occluded with silastic tapes.

The target vessel was exposed and incised with a lancet endoscopic knife. The internal mammary artery was sutured robotically to the target vessel using a 7/0 Pronova (PN 8713; Johnson & Johnson, New Brunswick, NJ, USA) running suture. In AH-TECAB, the intraaortic balloon pump was restarted before weaning from cardiopulmonary bypass; in BH-TECAB, the IABP was used throughout the whole case.

IABP weaning followed standard patient protocol in the cardiac surgery intensive care unit.

Data Collection

All patients gave informed consent for the procedure. Patient data were entered prospectively into a database, which was approved by the institutional review board of the University of Maryland School of Medicine.

Statistics

Categorical variables are shown as absolute numbers or percentages; continuous variables are given as mean and range.

RESULTS

Intraoperative variables are listed in Table 2.

There were no incidences of in hospital or 30-day mortality in this cohort. There were also no major intraoperative technical issues with the placement of the aortic cannula. Hemodynamic stability was preserved in all patients in the time between suspension of IABP function and initiation of cardiopulmonary support. There were also no issues seen with the postoperative function of the IABP. All IABPs were successfully weaned within 24 hours of the procedure.

Short-term outcome variables can be seen in Table 3.

DISCUSSION

We present our early experience with patients undergoing successful TECAB with a preoperatively placed IABP for either unstable angina or low left ventricular ejection fraction.

In conventional cardiac surgery the need for an IABP preoperatively is associated with significant increases in both operative morbidity and mortality. This has been illustrated consistently in the Society of Thoracic Surgeons (STS) risk model [Shroyer 1999; Shahian 2009]. According to the most recent STS risk model publication, a preoperatively placed

Table 2. Intraoperative Variables*

Conversion to larger thoracic incision, n (%)	0 (0)
Operative time, min	359 (263-565)
Cardiopulmonary bypass time, min	126 (114-138)
Aortic dissection, n (%)	0 (0)

*Data are presented as mean (range) unless otherwise indicated.

Table 3. Short-Term Outcomes*

Ventilation time, h	48 (21-114)
Intensive care unit stay, h	90 (63-142)
Hospital stay, d	9 (5-13)
Atrial fibrillation, n (%)	1 (20)
Deep thoracic wound infection, n (%)	0 (0)
Transitory ischemic attack/stroke, n (%)	0 (0)
30-day mortality, n (%)	0 (0)

*Data are presented as mean (range) unless otherwise indicated.

IABP has an odds ratio of 1.41 and 2.56 for mortality and prolonged mechanical ventilation, respectively. Furthermore, Brown and coworkers showed an odds ratio of greater than 3 for renal failure in patients with a preoperative IABP [Brown 2007].

Additionally, robotic TECAB, especially during its learning curve, has been reported to have longer operative and cardiopulmonary support times compared to conventional CABG [Argenziano 2006; Bonatti 2009; Bonatti 2010; Srivastava 2010]. A prophylactic IABP in higher risk patients may therefore be helpful during the implementation phase of TECAB. Prifti and coworkers have shown that cardiopulmonary bypass in a decreased ejection fraction left ventricle is particularly injurious [Prifti 2000]. In an already ischemic or reduced function heart, prolonged operative times in TECAB may be disadvantageous. In beating heart TECAB, unstable patients or patients with significantly reduced left ventricular function may be at higher risk for intraoperative ischemia or left ventricular decompensation. This is the reason why IABP and prophylactic heart–lung machine were generously installed.

In our cohort, there were no technical challenges to the placement of cannulae despite the presence of the deflated IABP in the descending thoracic aorta. Perhaps because of the brevity of time between suspension of IABP function and initiation of cardiopulmonary support, hemodynamic stability was preserved in all patients during that time period. Postoperative IABP function was maintained, and short-term patient outcomes were excellent.

CONCLUSION

This early experience suggests that TECAB is feasible in patients with a preoperatively placed IABP. Both the beating heart and arrested heart versions can be utilized in this patient population, further broadening the spectrum of applicability of this procedure. Future studies with larger numbers of patients are necessary to show if a reduction of the surgical trauma in TECAB can be of special value in patients who require prophylactic IABP placement.

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