

Myocardial enzyme release in totally endoscopic coronary artery bypass grafting on the arrested heart

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Objective: Robotic totally endoscopic coronary artery bypass grafting enables coronary artery bypass grafting without sternotomy or thoracotomy. However, longer cardiopulmonary bypass and aortic endo-occlusion times are currently required compared with those of standard coronary artery bypass grafting operations. We investigated whether longer operation times affect the myocardial enzyme release and the postoperative course.

Methods: From 2001 through 2006, 85 patients with a median age of 58 years (range, 31–76 years) underwent totally endoscopic coronary artery bypass grafting on the arrested heart by using the da Vinci telemanipulator and remote access perfusion through the femoral vessels (Estech or Heartport). The operations involved the left internal thoracic artery–left anterior descending coronary artery or diagonal branch (n = 74); right internal thoracic artery–right coronary artery (n = 2); double-vessel left internal thoracic artery–obtuse marginal branch/circumflex artery and right internal thoracic artery–left anterior descending coronary artery (n = 8); and double-vessel left internal thoracic artery–left anterior descending coronary artery and saphenous vein graft–right coronary artery (n = 1). Totally endoscopic coronary artery bypass grafting duration was 254 minutes (range, 178–710 minutes), cardiopulmonary bypass time was 114 minutes (range, 57–428 minutes), and aortic endo-occlusion time was 65 minutes (range, 28–230 minutes).

Results: The postoperative ventilation time was 8 hours (range, 0–278 hours), and the intensive care unit stay was 20 hours (range, 11–389 hours). The postoperative stay at our department was 6 days (range, 4–22 days), and we observed no hospital deaths in this series. Forty-five percent of the patients had an increased postoperative peak creatine kinase MB level, and 75% had an increased troponin T level. Postoperative peak creatine kinase MB levels significantly increased with totally endoscopic coronary artery bypass grafting duration ($r = 0.588$, $P < .001$), cardiopulmonary bypass time ($r = 0.521$, $P < .001$), and aortic endo-occlusion time ($r = 0.400$, $P < .001$) and translated into moderately prolonged intensive care unit stay ($r = 0.432$, $P < .001$) and ventilation time ($r = 0.517$, $P < .001$). Creatine kinase MB levels were not associated with sex, age, or EuroSCORE. The postoperative left ventricular ejection fraction did not differ significantly from the preoperative left ventricular ejection fraction.

Conclusions: Myocardial protection can be established in arrested heart totally endoscopic coronary artery bypass grafting operations. An influence of increased myocardial enzyme release on postoperative ventilation time and intensive care unit stay is detectable but does not translate into an early mortality or a decrease in left ventricular ejection fraction.

Myocardial enzyme release after standard coronary artery bypass grafting (CABG) occurs frequently and has been documented, especially for creatine kinase MB (CK-MB), troponin T, and troponin I.¹⁻³ Totally endoscopic CABG (TECAB) is an evolving technology and is meanwhile an

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Abbreviations and Acronyms

| | |
|---------|---|
| AHTECAB | = arrested-heart totally endoscopic coronary artery bypass grafting |
| CABG | = coronary artery bypass grafting |
| CK-MB | = creatine kinase MB |
| CPB | = cardiopulmonary bypass |
| ICU | = intensive care unit |
| LAD | = left anterior descending coronary artery |
| LITA | = left internal thoracic artery |
| LVEF | = left ventricular ejection fraction |
| RCA | = right coronary artery |
| RITA | = right internal thoracic artery |
| TECAB | = totally endoscopic coronary artery bypass grafting |

established procedure at our department of cardiac surgery.⁴⁻⁸ The advantage of TECAB is the avoidance of sternotomy or thoracotomy. Furthermore, hybrid revascularization concepts with endoscopic internal thoracic artery grafting and percutaneous coronary intervention can be realized.^{9,10} Earlier resumption of daily activities, such as housework, driving a car, or biking, has been demonstrated for TECAB operations compared with results from sternotomy operations.¹¹

Our procedure of choice for arrested-heart TECAB (AHTECAB) is to use femoral access cardiopulmonary bypass (CPB) with balloon endo-occlusion of the ascending aorta and intermittent antegrade cardioplegia. CPB times and aortic endo-occlusion times (ie, myocardial ischemic times) are longer compared with those of conventional CABG techniques. Hence, we aimed to quantify myocardial enzyme release and to compare results with historical values of standard CABG operations from the literature. Furthermore, we wanted to find preoperative, operative, and postoperative factors that are associated with an increased myocardial enzyme release. Finally, we investigated whether the myocardial enzyme release impaired myocardial contractility.

Materials and Methods

The institutional review board approved the TECAB operations, and informed consent was obtained from all patients.

Surgical Technique

Eighty-five patients (EuroSCORE 1 [range, 0-5]) were intended to undergo AHTECAB with the da Vinci telemanipulator (Intuitive, Inc) through 3 left-sided (right-sided in 2 right internal thoracic artery [RITA]-right coronary artery [RCA] grafts) thoracic ports (1 camera port in the fifth and 2 working ports in the third and seventh intercostal spaces). Femoral access CPB was established with balloon endo-occlusion of the aorta for cardiac arrest, followed by antegrade cardioplegia (ESTECH from ESTECH,

Table 1. Patient demographics of 85 patients in whom AHTECAB was intended

| Variable | Median (range) or percentage |
|--|------------------------------|
| Male sex | 78% |
| Age (y) | 58 (31-76) |
| Preoperative serum creatinine ≥ 1.2 mg/dL | 12% |
| History of smoking | 35% |
| Diabetes mellitus | 12% |
| Hypercholesterolemia | 68% |
| Hypertriglyceridemia | 17% |
| Arterial hypertension | 79% |
| Chronic obstructive pulmonary disease | 15% |
| Peripheral vascular disease | 2% |
| History of myocardial infarction | 28% |
| History of percutaneous coronary intervention | 37% |
| History of stroke | 1% |
| Carotid artery stenosis | 2% |

AHTECAB, Arrested-heart totally endoscopic coronary artery bypass grafting.

Inc; Heartport from Heartport, Inc), as described in previous publications.⁵⁻⁷

Patient demographics are listed in Table 1.

The operations performed were left internal thoracic artery (LITA)-left anterior descending coronary artery (LAD) or Dg (n = 74); RITA-RCA (n = 2); double-vessel LITA-OM/circumflex artery and RITA-LAD (n = 8); and double vessel LITA-LAD and saphenous vein graft-RCA (n = 1). Two LITA-LAD and saphenous vein graft-marginal branch CABGs were performed through a sternotomy after conversion was necessary. In a total of 85 intended AHTECABs, 13 (15.3%) conversions were necessary (n = 1 minithoracotomy and n = 12 sternotomies). In the second half of the series, the conversion rate decreased to 4 (9.3%) of 43.

The TECAB duration was 254 minutes (178-710 minutes), CPB time was 114 minutes (57-428 minutes), and aortic endo-occlusion time was 65 minutes (28-230 minutes).

Postoperatively, the myocardial enzymes were measured at the time the patient arrived at the intensive care unit (ICU), as well as 4 hours, 8 to 12 hours, and 32 to 36 hours postoperatively.

Postoperative peak levels of absolute CK-MB could be obtained from 77 of 85 patients. Postoperative peak levels of troponin T were obtained from 47 of 85 patients because troponin T levels were measured only during the second two thirds of the study.

Statistical Analysis

Statistical analysis was carried out with SPSS 12.0 software (SPSS, Inc). Continuous variables are given as medians (minimum-maximum). Categorical variables are given as percentages. The Pearson correlation coefficient (*r*) was calculated for continuous variables. The Mann-Whitney *U* test was applied for comparisons of enzyme levels with categorical factors. The Wilcoxon test for paired samples was used to compare preoperative and postoperative left ventricular ejection fraction (LVEF).

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