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Anesthesia for Cardiac Transplantation: Experience From a Single Center

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ABSTRACT

Background. Cardiac transplantation has become the established therapeutic modality in patients with end-stage heart failure. This article presents our institution's clinical experience in the anesthetic management of patients who underwent cardiac transplantation between February 1998 and August 2012.

Methods. In our institution, 175 patients (136 males and 39 females) diagnosed as having end-stage heart failure have undergone cardiac transplantation between February 1998 and August 2012. A retrospective review performed on this series of patients sought to analyze elements of perioperative anesthetic care, including preoperative characteristics, general anesthia, and blood product usage.

Results. The patients were diagnosed as having either nonischemic cardiomyopathy (n = 128; 73%) or ischemic cardiomyopathy (n = 47; 27%). Seventy-three of them had undergone previous cardiac surgery. Invasive arterial, central venous, and pulmonary arterial pressures were monitored as well as intraoperative transesophageal echocardiography. Etomidate was used as the induction agent in 158/175 patients (average dose, 18.67 ± 1.91 mg). The average intraoperative fentanyl dose was 898.85 ± 211.65 μg. Anesthesia was maintained with either end-tidal 2%–4% sevoflurane (n = 132) or 4%–6% desflurane (n = 43). Dopamine, dobutamine, and epinephrine were used after weaning from cardiopulmonary bypass and continued upon exiting the operating room in 168, 159, and 143 patients, respectively. Inhaled nitric oxide (20–40 ppm) was used in 37 patients (21%). The total amount of perioperative blood, fresh frozen plasma, and thrombocyte suspension transfusions were 2.95 ± 2.05 (range, 1–15), 1.29 ± 0.97 (range, 0–6), and 1.23 ± 2.29 (range; 0–12) units, respectively. On average, patients were extubated 16 hours after arrival in the intensive care unit where they remained to day 6. A total of 67 patients (38%) died during the follow-up; infection and right ventricular failure were the most common causes.

Conclusion. Anesthesia for cardiac transplantation requires an appreciation of heart failure pathophysiology, invasive monitoring, and skillful anesthetic and postoperative care.

SURVIVAL after heart transplantation has progressively improved over the past decades as a result of developments in immunosuppressive and surgical therapies. Although the limited availability of donor organs is still a major concern, cardiac transplantation has become the established therapeutic modality for patients with end-stage heart failure.[1,2] The perioperative management of these patients involves challenges for the anesthesiologist because severe cardiomyopathy is marked by systolic and

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diastolic dysfunction and altered physiology that produces end-organ injury.[2,3] This article presents our institution's clinical experience in the anesthetic management of patients who underwent cardiac transplantation between February 1998 and August 2012.

METHODS

Among 175 patients, including 136 males and 39 females who were diagnosed with end-stage heart failure and underwent cardiac transplantation between February 1998 and August 2012, 128 (73%) had nonischemic cardiomyopathy and 47 (27%) had ischemic cardiomyopathy. Seventy-three patients (41%) had undergone previous cardiac surgery. The cardiac recipient waiting list was categorized by 2 levels: status 1, the need for intensive care with high-dose inotropes, including an intra-aortic balloon pump (IABP) or a left ventricular assist device; and status 2, which included outpatient with compensated cardiac failure. At the time of transplantation 124 patients (70%) were status 1 and 51 (30%) were status 2. A retrospective review of this patient series analyzed elements of perioperative anesthetic care.

Preoperative patient data were extracted from patient folders: demographic features congestive heart failure etiology clinical status, last two-dimensional echocardiography left ventricular ejection fraction, and prior left ventricular asist device (LVAD), Biventricular asist device (BIVAD), implantable cardioverter defibrillator (ICD) placement. Intraoperative and postoperative patient data were extracted from the anesthesia and intensive care unit (ICU) record respectively. The intraoperative data included the following: intravenous (IV) access, including peripheral and central lines; anesthetic drugs administered, such as the induction drug and dose; volatile anaesthetic agent; intraoperative fentanyl dose; and muscle relaxant. Also recorded from the intraoperative record were the duration of cardiopulmonary bypass (CPB) and cross-clamp, post-pump pacing, vasoactive medications upon exiting the operating room, and blood product transfusions. Postoperative data collected from ICU records included transfusions, time to extubation, and postoperative day of ICU discharge. Data were collected on all 175 patients who underwent cardiac transplantation between February 1998 and August 2012.

Statistics

Continuous data are presented as mean values ± standard deviations; discrete variables are presented as percentages and total number.

RESULTS

Patient demographic features and preoperative characteristics are summarized in Table 1 Our institutional protocol included the following: 1 16G/18G IV catheter and a 20G radial arterial cannula inserted in the operating theater. Continuous monitoring was done with DII and V5 electrocardiogram (ECG) leads with ST segment analysis (Horizon XL, Mennen Medical Inc., Southampton, USA). After establishing the ECG and invasive arterial pressure monitoring, we induced anesthesia.

Etomidate was used as the induction agent in the majority of patients (n = 158 patients; mean dose, 18.67 ± 1.91 mg). The other patients were anesthetized with either thiopental (n = 10 patients) or a midazolam-ketamine combination (n = 7 patients). Fentanyl was used as the intraoperative analgesic for all of the patients (mean dose, 898.85 ± 211.65 μg). Neuromuscular relaxation was provided using either 0.1 mg/kg pancuronium (n = 18), 0.1 mg/kg vecuronium (n = 59), or 1 mg/kg rocuronium (n = 98). The intubated patients were mechanically ventilated targeting an end-tidal CO_2 partial pressure of 32–40 mm Hg (Ventilator 710; Siemens, Solna, Sweden). Anesthesia was maintained with either end-tidal 2%–4% sevoflurane (n = 132) or 4%–6% desflurane (n = 43) in 50% oxygen-50% mixture. Propofol infusion and midazolam (2.5–5 mg) were used to supplement anesthesia in the majority of patients (n = 158; 90%). A triple-lumen central venous catheter (Certofix Duo, B. Braun Melsungen A.G., Germany) in the internal jugular vein was used as the central venous route in the majority of patients (n = 163; 93%), with the subclavian route for the others as well (n = 12; 7%). In addition, a pulmonary artery catheter with an introducer sheath was used for all cases. We continuously monitored central venous and pulmonary arterial pressures, central and rectal body temperatures, intraoperative transesophageal echocardiography and urine output. Fluid replacement was established using crystalloids or colloids guided by the hemodynamic data. The mean amounts of perioperative blood, fresh frozen plasma, and thrombocyte suspension transfusion were 2.95 ± 2.05 (range, 1–15), 1.29 ± 0.97 (range, 0–6), and 1.23 ± 2.29 (range, 0–12) units, respectively. Nitroglycerine infusion (0.5–2.0 μg/kg/min) was administered to all patients, with inhaled nitric oxide (20–40 ppm) in 37 subjects (21%). Dopamine, dobutamine, and epinephrine infused after weaning from CPB were continued upon exiting the operating room in 168, 159, and 143 patients, respectively (Table 2).

The operations were performed through a midline sternotomy with bicaval cannulation with an arterial cannula in the aorta. Once CPB was commenced, the ascending aorta was cross-clamped to avoid embolization from the left ventricle. The recipient heart was removed from the mediastinum leaving 2 atrial cuffs in situ along with the caval and

Table 1. Preoperative Patient Characteristics

No. of patients	175
Age (y, range)	39.61 ± 14.65
Body weight (kg)	65.18 ± 14.32
Gender (M/F)	136/39
Etiology of congestive heart failure	
Ischemic	n = 47 (27%)
Nonischemic	n = 128 (73%)
Status	
Status 1	n = 124 (70%)
Status 2	n = 51 (30%)
Left ventricular ejection fraction (%)	21.60 ± 6.18
Previous open heart surgery (%)	n = 78 (44%)
Bridge to transplantation	n = 37 (21%)
Preoperative IABP	n = 5 (2.9%)
Preoperative ICD	n = 24 (13.7%)

Abbreviations: M, male; F, female.