Abdominal Surgery in Patients with a Ventricular Assist Device: A Single Center Experience in Israel

Veacheslav Zilbermints MD, Oren Israeli MD, Binyamin Ben Abraham MD, Tuvia Ben-Gal MD, Victor Rubchevsky MD, Dan Aravot MD, Hanoch Kashtan MD, Nikolai Menasherov MD, and David Aranovich MD

Departments of 1 Surgery, 2 Cardiology, and 3 Cardiothoracic Surgery, Rabin Medical Center (Beilinson Campus), Petah Tikva, Israel

1 Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel
2 Rappaport Faculty of Medicine, Technion–Israel Institute of Technology, Haifa, Israel
3 Surgical Division, Hillel Yaffe Medical Center, Hadera, Israel

ABSTRACT

Background: Left ventricular assist devices (LVADs) are used more commonly in patients with advanced-stage heart failure. Some of these patients may require elective or urgent abdominal surgical procedures.

Objectives: To determine the outcomes of the management of LVAD-supported patients who underwent elective and urgent abdominal surgical procedures in our institution.

Methods: A retrospective review was conducted on 93 patients who underwent LVAD implantation between August 2008 and January 2017. All abdominal surgeries in these patients were studied, and their impact on postoperative morbidity and mortality was evaluated.

Results: Ten patients underwent abdominal surgical procedures. Of these procedures, five were emergent and five were elective. The elective case included one bariatric surgery for morbid obesity, one hiatal hernia repair, two cholecystectomies, and one small bowel resection for a carcinoid tumor. The emergency cases included suspected ischemic colitis, right colectomy for bleeding adenocarcinoma, laparotomy due to intraabdominal bleeding, open cholecystectomy for gangrenous cholecystitis, and laparotomy for sternal and abdominal wall infection. All patients undergoing elective procedures survived. Of the five patients who underwent emergency surgery, three died (60%, \( P = 0.16 \)) and one presented with major morbidity. One of the two survivors required reintervention. In total, 12 interventions were performed on this group of patients.

Conclusions: It is safe to perform elective abdominal procedures for LVAD-supported patients. The prognosis of these patients undergoing emergency surgery is poor and has high mortality and morbidity rates.

KEY WORDS: elective surgery, emergency surgery, left ventricular assist devices (LVADs), heart failure

RESULTS

Of the 93 patients implanted with durable LVADs who were identified in the retrospective data review, 51 (55%) received a HeartMate II (Abbott, Abbott Park, IL, USA) device, 28 (30%) received a HeartWare (HeartWare, Framingham, MA, USA), 10 (11%) received a HeartMate III, and 4 patients (4%) received other devices. Of the 80 patients who were included in the study, growing experience and technological advancements, LVADs are implanted not only as a bridge therapy to heart transplantation, but also as a destination therapy. The outcome of this medical and technological revolution is impressive as many patients live better and longer lives [1]. The increased life expectancy of these patients has exposed them to other non-cardiac, health-related events. Thus, our study focused on the need for abdominal surgical procedures, either elective or urgent, with the objective of presenting our institution’s experience in managing LVAD patients who underwent elective and emergency abdominal surgeries [2].
10 underwent abdominal surgical procedures (12.5%). Of those 10, 5 required emergency surgery and 5 had elective surgery. All patients who underwent surgery were supported with fully implantable LVADs. The clinical characteristics of the patients in the two groups are shown in Table 1 and Table 2.

All patients in the elective group had some degree of functional disability, and were given an ASA score of III, indicating a severe systemic disease that is not life-threatening. All patients in the emergency surgery group were given a score of ASA IV-E, which denotes ASA class IV involving an emergency surgical procedure where a delay in surgical treatment would be life-threatening. All perioperative management in these patients was implemented by an experienced team of senior anesthesiologists, accompanied by a dedicated LVAD technician. General anesthesia was administered to all patients. During the procedure, the LVAD technician aided in programming and adjusting the pump speed and power.
according to the physiological requirements of the patient. Blood pressure was monitored with an arterial line.

Of the five elective cases, one patient underwent bariatric surgery for morbid obesity, one had symptomatic hiatal hernia, two were operated for symptomatic gallbladder disease, and one underwent small bowel resection for a carcinoid tumor causing blood loss and anemia.

All patients tolerated their respective procedures well. Neither mortality nor major morbidity was observed [Table 1]. In our series, anticoagulation was discontinued 3–5 days before elective procedures, and oral Warfarin was bridged with subcutaneous enoxaparin (Clexan®). Preoperative anemia was corrected with blood transfusions in two elective patients: a patient with a hiatal hernia with gastric erosions and a patient with a small bowel carcinoid tumor. These patients presented with chronic blood loss due to the underlying conditions, and the hemoglobin concentration of more than 10 g/dl was required prior to the procedures. Neither of these patients required postoperative blood transfusions. One elective sleeve gastrectomy patient and one elective cholecystectomy patient required postoperative blood transfusions of two packed cell units to maintain the hemoglobin levels up to 10 mg/dl. The estimated blood loss in all elective cases was reported as minimal according to the operative surgical reports. There was no clinical evidence of postoperative bleeding in these patients.

Five patients had emergency surgery including laparoscopy for suspected ischemic colitis, right colectomy for bleeding adenocarcinoma, laparotomy due to intra-abdominal bleeding, open cholecystectomy for gangrenous cholecystitis, and laparotomy for sternal and abdominal wall infection management.

Preoperative anemia in three emergency surgery patients with hemoglobin levels below 10 mg/dl was corrected en route to the operating room with blood transfusions. In the emergency surgery group, one patient who showed multiple organ failure and eventually died required multiple blood transfusions. Two patients who died postoperatively after cholecystectomy also required blood transfusions.

The patients who underwent emergency surgery had substantial mortality and morbidity. Three patients died within 30 days of surgery (60%, P = 0.16) and one presented with a major (grade IV) morbidity [Table 2]. One of the two survivors required three additional surgical interventions to mitigate the complications. The total number of interventions was 12 for the five patients in the emergency surgery group [Table 3].

**DISCUSSION**

In 1994, ventricular assist devices were approved by the U.S. Food and Drug Administration in the United States for the treatment of end-stage heart failure, inotrope dependent patients, and patients with intractable arrhythmias, especially when LVEF fell below 25% [5,6]. Since then, the use of these devices has become more prevalent due to technological advances and broadening of the clinical indications [7]. In addition, the progress of continuous flow technology has led to a remarkable rise in 1- and 2-year survival rates, which have been reported as 88% and 80%, respectively [8,9]. The number of LVAD-supported patients is rising and, as expected, they may need general surgical abdominal procedures, which imposes a number of unique anesthesia related and perioperative challenges. The blood flow generated by the device is unidirectional and patient hemodynamics depends entirely on filling volume and outflow resistance. The device propels the blood from the left ventricle to
the aorta. When the impeller revolves, the blood flows from the left ventricle into the aorta, thus bypassing the failed left ventricle. Since the LVAD supports the failed left ventricle, its performance requires a high overall function of the right ventricle. The main anesthetic strategy during surgery in LVAD supported patients is to avoid hypovolemia and also to prevent or counteract right heart failure. Contrary to the heart’s native response, no Starling effect is present with LVAD-driven hemodynamics; hence, the device can only pump the volume delivered to it and inadequate filling will result in decreased flow with a resulting decreased stroke volume. This preload and afterload sensitivity mandates careful attention to the administration of intravenous fluids as well as blood loss during surgery. The main goal in the perioperative management of these patients is the attenuation of sympathetic nervous system activity produced by laryngoscopy, intubation, or surgery itself.

Several studies have addressed this issue in the past. As early as 1995, Goldstein et al. [10] described 12 patients with LVADs who underwent non-cardiac surgical procedures. Those authors reported minimal morbidity and no mortality in their study. Subsequent studies reported the rates of non-cardiac surgical procedures in patients on mechanical circulatory support to be around 18–27%, although some studies included procedures such as dental extractions, tracheostomies, insertion of feeding tubes, catheter insertions, vascular, urologic, cataract, and other surgeries [11-14].

Due to the limited number of existing studies with relatively small sample sizes and widely heterogeneous data, some reported no postoperative deaths and others reported 30-day postoperative mortality rates ranging from 6.4 to 16.7% [15]. As a reflection of the available data, the main limitation of our study is the small number of patients, which makes interpretation of the variables such as morbidity and mortality very difficult. Unfortunately, we cannot comment on the intraoperative metabolic status of the patients, since the blood gas results were not documented in the electronic database of anesthetic reports during the study period, and were not available for the retrospective analysis.

In our experience, 12.5% (10/80) of patients with LVADs required general abdominal procedures. This number is consistent with that found in other reports. There was no mortality and minimal morbidity observed in the patients that underwent elective surgery. The patients who underwent emergency procedures had negative outcomes. They showed high mortality rates (60%), encountered major complications, required more blood transfusions, and required multiple follow-up surgeries. As expected, the patients who underwent emergency surgery had higher ASA scores of IV with an emergency nominator (E), which reliably reflects the severity of their preoperative conditions and also predicts a poor outcome. Only one patient in the emergency group who had surgery for suspected ischemic colitis did well. She underwent a normal diagnostic laparoscopy, and ruled out any abdominal pathology. She recovered without sequela. Other patients with established life-threatening abdominal emergencies had poor outcomes. Three died and one required additional surgery.

**CONCLUSIONS**

There is a growing population of patients with LVADs, and many of them will require general surgical interventions unrelated to their cardiac status. According to our experience, elective abdominal procedures are safe in LVAD-supported patients. The prognosis of LVAD-dependent patients who undergo emergency surgery is poor with high mortality and morbidity rates.

**Correspondence**

Dr. D. Aranovich  
Surgical Division  
Hillel Yaffe Medical Center, Hadera 38100, Israel  
email: aradair@yahoo.com

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LVAD = left ventricular assist device