Is hemodynamic transesophageal echocardiography needed for patients with left ventricular assist device?

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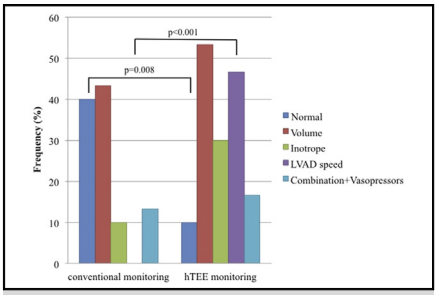
ABSTRACT

Background: Interventions in patients with a left ventricular assist device (LVAD) in the intensive care unit (ICU) are typically performed based on the results of conventional monitoring, such as vital signs and Swan–Ganz catheter (SGC) and LVAD parameters. These variables might not always accurately reflect a patient's cardiac function, volume status, and interventricular septal configuration, however. To assess the accuracy of standard monitoring, we performed routine continuous hemodynamic transesophageal echocardiography (hTEE) to evaluate cardiac function, volume status, and septal position.

Methods: Between 2011 and 2015, 93 HeartMate II LVADs were implanted. The study group comprised 30 patients with an SGC in place who were monitored routinely by hTEE in the ICU every 1 to 3 hours until extubation. A total of 147 hTEE studies were analyzed retrospectively to observe differences between conventional monitoring and hTEE.

Results: Among the 30 patients studied, 26 (87%) had at least 1 disagreement between conventional monitoring and hTEE findings. In 22 patients (73%), at least 1 of the hTEE studies was abnormal whereas conventional parameters were normal. Abnormal hTEE findings included a shift in the interventricular septum in 19 patients (63%), abnormal ventricular volume status in 22 patients (73%), and right ventricular failure in 9 patients (30%). Based on conventional monitoring, none of the patients required an LVAD speed change, whereas hTEE showed that 14 patients (47%) needed an LVAD speed adjustment.

Conclusions: Conventional monitoring in the ICU might not provide an accurate representation of cardiac function, ventricular volume status, or septal position in patients with LVAD. Continuous monitoring with hTEE in patients with an LVAD may help guide optimal intervention in the ICU setting during the early postoperative period. (J Thorac Cardiovasc Surg 2017;■:1-7)



Comparison of interventions in 30 patients from conventional hemodynamic monitoring and hTEE monitoring. hTEE monitoring often suggest LVAD speed change.

Central Message

Swan–Ganz monitoring might not be sufficient to monitor cardiac function and volume status of patients with LVAD. We advocate the use of hTEE as an adjunct for patient monitoring.

Perspective

Interventions in patients with LVAD are typically based on conventional monitoring, which includes Swan–Ganz catheter parameters. We found that conventional monitoring might not always accurately reflect a patient's cardiac function, volume status, and interventricular septal position. Additional hTEE monitoring may be beneficial in choosing the optimal intervention for patients with LVAD.

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PM

Postoperative management in the intensive care unit (ICU) of patients who underwent left ventricular assist device (LVAD) placement is typically based on clinical variables, such as Swan–Ganz catheter (SGC) parameters, vital signs, and LVAD device parameters. An SGC is placed intraoperatively to monitor pulmonary pressure, cardiac output, and vascular resistance. The benefit of an SGC in patients who have undergone cardiac surgery has been widely debated.[1] Several studies have shown that SGC use may provide little benefit or lead to worse outcomes in septic, critically ill, or high-risk surgical patients.[2-5] How accurately SGC parameters reflect cardiac function,

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Scanning this QR code will take you to a supplemental video.

Abbreviations and Acronyms

CVP = central venous pressure
ECMO = extracorporeal membrane oxygenation
hTEE = hemodynamic transesophageal echocardiography
ICU = intensive care unit
LVAD = left ventricular assist device
MAP = mean arterial pressure
SGC = Swan–Ganz catheter

interventricular septal position, or ventricular volume status in patients with an LVAD remains unclear.

As reported previously,[6] hemodynamic transesophageal echocardiography (hTEE) is a disposable, flexible 5.5-mm-diameter transesophageal probe that has been approved by the Food and Drug Administration for cardiac monitoring of patients in the ICU for 72 hours per probe. The probe allows physicians to perform rapid qualitative and semiquantitative assessment of cardiac function, ventricular volume status, and ventricular septal configuration.[7] In particular, hTEE findings can be used to adjust LVAD speed based on interventricular septal position and help guide proper fluid and inotrope administration, relying on the observed right ventricular function and ventricular volume status. Information obtained from echocardiography has been used for postoperative management of cardiac surgery patients,[8] weaning off of extracorporeal membrane oxygenation (ECMO),[9] and diagnosis of postcardiotomy tamponade.[10]

A recent retrospective review showed that postoperative hTEE is typically performed in sicker patients who are greater risk of morbidity and mortality following LVAD implantation.[7] Furthermore, the study reported changes in clinical management based on hTEE findings in the majority of these patients.[7] We hypothesized that conventional monitoring with an SGC in patients with an LVAD might not reflect ventricular volume status, right ventricular function, and interventricular septal configuration as accurately has been demonstrated by point-of-care hTEE monitoring, and that routine hTEE could lead to changes in the clinical management of patients with LVAD, even in those with standard SGC monitoring.

METHODS

Between May 2011 and May 2015, a total of 93 HeartMate II LVADs (Thoratec, Pleasanton, Calif) were implanted in our hospital. All 93 patients with an LVAD underwent conventional hemodynamic monitoring with an SGC. Among the 93 patients, 30 patients also underwent routine continuous hTEE (ImaCor hTEE; ImaCor, Garden City, NY), performed every 1 to 3 hours by qualified intensivists, in addition to conventional SGC monitoring and recording of LVAD parameters. The cost of the hTEE was approximately $1250 per probe. Eligibility criteria for the hTEE study included the presence of hTEE-trained personnel and availability of the hTEE device. A total of 147 hTEE studies were conducted in 30 patients until extubation under standard sedation used routinely after cardiac surgery. The hTEE images were retrospectively retrieved from the console after approval from the Thomas Jefferson University's Institutional Review Board (IRB #11D.451). All hTEE studies yielded images of adequate quality for review and analysis. The data from conventional hemodynamic monitoring, including LVAD and SGC parameters, patient demographic information, and hTEE recordings, were stored in a database for our retrospective analysis.

Conventional hemodynamic monitoring included mean arterial pressure (MAP), heart rate, central venous pressure (CVP), pulmonary artery systolic and diastolic pressure, cardiac index, and LVAD parameters, which included speed, flow, pulsatility index, and power. Based on conventional monitoring, volume status was defined based on low CVP, MAP, and LVAD pulsatility index. Based on hTEE, volume status was evaluated and defined as euvolemia, hypovolemia, or hypervolemia, based on left ventricular cavity size. The position of the interventricular septum was evaluated by hTEE and categorized as midline, shifted to the right, or shifted to the left. By conventional monitoring, right ventricular failure was defined as high CVP with a concomitant low cardiac index. By hTEE, right ventricular function was categorized as hypokinetic, normal, or hyperdynamic. No patient had right ventricular failure necessitating mechanical support. The management algorithm for conventional monitoring and a potential patient management algorithm for monitoring by hTEE are shown in Figure 1.

Data for conventional hemodynamic monitoring (without hTEE) were analyzed using absolute numbers and trends in parameters from previous hTEE study time points. Based solely on these conventional parameters, patients were divided into 2 groups, a group requiring intervention(s), such as adjustments of volume, vasopressors, and inotropes and changes in LVAD speed, and a normal group, defined as not requiring intervention, at each time point. A similar analysis was performed taking hTEE findings into consideration. The interventions suggested by conventional monitoring results were compared with those suggested by hTEE findings.

Demographic data, preimplantation diagnoses, postoperative SGC parameters and LVAD settings, and reasons for LVAD implantation were also compared between the 63 patients who did not receive hTEE monitoring (non-hTEE group) and the 30 patients who received hTEE monitoring (hTEE group). Survival at 30 days, 6 months, 12 months, and 24 months was analyzed using a Kaplan–Meier curve.

Data are expressed as number with percentage, mean ± standard deviation with range, or mean ± standard deviation and median with range and interquartile range. Statistical comparisons between the conventional monitoring and hTEE groups were performed using the χ^2 or Fisher exact test, as appropriate, for categorical variables, and using the standard t test or Mann–Whitney U test, as appropriate, for continuous variables. Cohen's κ, reflecting the agreement between conventional monitoring and hTEE, was calculated. Log-rank test P values and 95% confidence intervals were calculated for Kaplan–Meyer analysis. A P value $< .05$ was considered to indicate significance.

RESULTS

Routine postoperative hTEE studies were performed in 30 patients who underwent LVAD implantation and compared with SGC and LVAD data. A mean of 5 ± 2 hTEE studies (range, 3-12) per patient were performed during the postoperative period. There were no adverse events related to hTEE, such as esophageal injury or oropharyngeal injury, during the study period. The 30 patients in the hTEE group included 23 males and 7 females, with a mean age of 56 ± 12 years (Table 1). The 30-day survival was 100% in this group, but 6 patients