Utility of Perioperative Transesophageal Echocardiography in Non-Cardiac Surgery

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Since the introduction of intraoperative echocardiography into clinical practice in the 1980s, its popularity has steadily increased. Although not as well established as for cardiac surgery, the benefit of perioperative echocardiography for non-cardiac surgery is becoming increasingly more appreciated. Selective or emergent intraoperative transesophageal echocardiography (TEE) has been reported as beneficial in 40% to 80% of patients respectively. In over one-third of patients, intraoperative TEE may be associated with a change in medical therapy, including treatment of myocardial ischemia, valvular pathology, and/or right ventricular (RV) and left ventricular (LV) failure. Furthermore, in approximately 25% of patients, intraoperative TEE has been associated with a change in surgical procedure. Based upon these findings, intraoperative echocardiography is rapidly becoming recognized for its impact on perioperative decision-making during non-cardiac surgery.

Indications for Intraoperative Echocardiography

Indications for emergent TEE during non-cardiac surgery have included hemodynamic instability, evaluation for chest trauma, hypoxemia, and pre-incision cardiac evaluation prior to emergent surgery. In 1996 practice guidelines were published from the American Society of Anesthesiologists (ASA) and the Society of Cardiovascular Anesthesiologists (SCA) Task Force on TEE. Recommendations are divided into three categories based on the strength of supporting evidence and/or expert opinion that TEE improves clinical outcomes. Category I indications are supported by the strongest evidence or expert opinion that TEE is frequently useful in improving clinical outcomes in these settings, and is often indicated. Category II indications are supported by weaker evidence and expert consensus that TEE may be useful in improving clinical outcomes in these settings but absolute indications are less certain. Category III indications have little scientific or expert support, and appropriate indications are uncertain. An updated revision of this document authored by members of the ASA and SCA is currently underway.

Although the ASA/SCA practice guidelines are perhaps most applicable for cardiac surgery, they also have relevance for non-cardiac surgery. One of the most common Category I indications for the use of intraoperative TEE during non-cardiac surgery, is the role of “rescue TEE” for the evaluation of acute persistent and life-threatening hemodynamic disturbances in which ventricular function and its determinants are uncertain or have not responded to treatment. In a study investigating the usefulness of TEE during intraoperative cardiac arrest in non-cardiac surgery, a primary suspected diagnosis of the underlying pathological process was established in 19 of 22 patients with TEE, including 9 with thromboembolic events, 6 with acute myocardial ischemia, 2 with hypovolemia, and 2 patients with pericardial tamponade. A definitive diagnosis could not be made in 3 patients with TEE. In 18 patients, TEE guided specific management beyond implementation of Advanced Cardiac Life Support protocols, including the addition of surgical procedures in 12 patients. A related Category II indication includes the perioperative use of TEE in patients with increased risk of hemodynamic disturbances. In several single center and multicenter studies, intraoperative TEE for non-cardiac surgery has been shown to influence surgical and anesthetic management in 30-40% of patients, including those who already had invasive hemodynamic monitors (i.e., radial arterial lines and pulmonary artery catheters). Changes in management have been based upon confirming or invalidating a prior diagnosis, detection of new diagnoses, and acquisition of pertinent information acquired during periods of hemodynamic instability leading to changes in drug or goal-directed fluid therapy, unplanned surgical re-interventions and further evaluation in the postoperative period. While many of the cases in the literature would be considered Category I indications for the utility of intraoperative TEE, others have reported a consistent impact of intraoperative TEE on perioperative clinical decision-making even for Category II indications among non-cardiac patients.
surgical patients. Thus, in addition to earlier reports suggesting a primary benefit for intraoperative TEE as a diagnostic tool for evaluating myocardial ischemia during non-cardiac surgery \(^1\), more recent reports also confirm its utility as a monitor of hemodynamic status and overall cardiovascular performance.

**Perioperative Ischemia Monitoring**

Ischemic changes detected by two-dimensional echocardiography include new systolic wall motion abnormalities (SWMA) and decreased systolic wall thickening. Echocardiography is also useful for evaluating complications of myocardial ischemia including myocardial infarction (MI), congestive heart failure (CHF), valvular regurgitation, septal defects, thrombi, pericardial effusions, and ventricular free wall rupture. Controlled studies have demonstrated a clear association between SWMA, coronary ischemia and cardiac events \(^1\). Data from perioperative TEE studies have reported specificities and negative predictive values >90%. However, sensitivity and positive predictive values for MI are less than 40%, possibly because not all ischemia results in MI \(^1\). In addition, SWMA often overestimate the area of injury, and may result from etiologies other than ischemia including myocardial stunning, hibernation and tethering as well as changes in loading conditions. While monitoring, diagnosing and treating myocardial ischemia is important, it is not clear that routine TEE is either cost-effective or more beneficial than ECG monitoring with ST segment analysis \(^1\). However, TEE may be a worthwhile monitor and a diagnostic tool of choice for the initial assessment of myocardial ischemia or MI-related complications for high-risk patients undergoing non-cardiac surgery.

**Vascular Surgery**

SWMA occur frequently during vascular surgery, but are less frequently associated with perioperative MI, CHF, and cardiac death. In one study, 55% of patients undergoing aortic reconstruction experienced new SWMA at the time of aortic clamping, with a greater incidence seen following supra-celiac clamping (92%) compared to suprarenal (33%), and infra-renal (0%) \(^1\). In this particular series, only 1 patient (in the supra-celiac group) suffered a perioperative MI.

As previously stated, SWMA may result from a variety of etiologies other than ischemia. Furthermore, even if all SWMA were indicative of ischemia or ventricular dysfunction, ischemia does not always result in a significant cardiac event. Anesthetic agents, metabolic changes, blood loss, and placement of the aortic cross clamp are known causes of SWMA. Since these are transient processes, the occurrence of an adverse cardiac event is reduced. The low positive predictive value of SWMA may also be associated with rapid detection and subsequent prompt treatment. Nonetheless, the utilization of TEE during major vascular procedures may influence perioperative management and outcome.

**Liver and Lung Transplantation**

Despite the presence of a coagulopathy and gastroesophageal varices, TEE has been used safely in patients undergoing liver transplantation, with a reported bleeding complication rate of 1-2% \(^1\). During liver transplantation, TEE monitoring has demonstrated new findings in > 50% of patients, improved hemodynamic management, and has been shown to impact overall perioperative care in 11% of patients \(^1\). During lung transplantation, TEE has been used to assess severity and etiology of pulmonary hypertension, intraoperative ventricular function, and surgical anastomotic integrity. Diagnoses such as pulmonary artery (PA) thrombi, patent foramen ovale, atrial septal and ventricular septal defects in 25% of patients, resulted in the requirement for additional surgery in one study \(^1\). Furthermore, echocardiographic visualization of pulmonary vascular anastomoses suggests that up to 30% may be abnormal, thus prompting additional surgical procedures \(^1\).
Orthopedics

Patients undergoing total hip replacement (THR) are vulnerable to perioperative cardiac complications due to comorbidity and hemodynamic instability occurring during certain aspects of the surgical procedure. Emboli released during preparation of the femur are readily diagnosed with TEE and have been associated with decreases in blood pressure, increases in PA pressure, RV and LV SWMA, and occasionally cardiovascular collapse. Emboli have also been diagnosed in patients undergoing total knee replacement following thigh tourniquet release. However, in comparison to THR, the hemodynamic consequences of these embolic events may not be as severe. Although TEE may not be indicated for all patients undergoing orthopedic procedures, elderly patients and those with significant cardiovascular and pulmonary comorbidity may benefit from its utility as a monitor and diagnostic tool for evaluating perioperative hemodynamics.

Neurosurgery

Hemodynamic instability during major neurological surgery is affected by a number of variables including patient demographics, anesthetic agents and surgical techniques. Venous air embolism (VAE), which may cause hemodynamic and pulmonary instability, occurs in 25-50% of neurosurgical procedures, and has been reported in as many as 76% of craniotomies performed in the sitting position. Although precordial Doppler echocardiography or TEE is believed to be the most sensitive monitor for VAE, actual utilization varies from 25-87%. Patients scheduled to undergo craniotomy in the sitting position should have a pre-surgical echocardiographic evaluation either preoperatively or immediately after induction of anesthesia to determine the presence of any intracardiac shunts.

Obstetrics

It is becoming increasingly more common for high-risk obstetrical patients with cardiac disease including congenital heart diseases, CAD, cardiomyopathies, and heart transplantation to present for peripartum care. In addition, a number of pregnancy-related conditions, including pregnancy-induced-hypertension, pulmonary emboli, hemorrhage, and peripartum cardiomyopathy have a significant influence on tolerance for the normal hemodynamic changes associated with pregnancy. Although echocardiographic analysis during normal deliveries is not cost-effective, use in assessing high-risk obstetric patients may be warranted.

Trauma and Critical Care

Prompt and accurate diagnoses of traumatic cardiac injuries are crucial to improving survival. In one study of penetrating chest injury, echocardiographic evaluation and diagnosis was achieved within 15 minutes, compared to 42 minutes in the non-echo group. The survival was 100% in the former and 57% in the latter. Compared to transthoracic echocardiography (TTE), TEE also significantly contributes to the diagnostic and hemodynamic evaluation of cardiac and vascular injury, and can be performed in as quickly as 9-15 minutes.

There is strong support for the use of echocardiography in critically ill patients. Common indications for postoperative echocardiography include evaluation of hypotension, LV and RV function, MR, prosthetic valves, aortic injury, pericardial pathology, myocardial ischemia, complications following MI, cardiac masses and sources of emboli or infection. Echocardiographic evaluation of hemodynamic instability, trauma, and hypoxemia are particularly common.

When compared to clinical impression, echocardiography has been shown to provide new information in 80% of critically ill patients, changed medical management in 60%, and led to a surgical procedure in as many as 30% of patients. Comparative analyses have shown that TEE improved cardiac evaluation compared to TTE in as many as 50-70% of patients.
Conclusions

Perioperative echocardiography for non-cardiac surgical patients is useful for diagnosing cardiovascular pathology and assessing hemodynamics. Echocardiographic evaluation of cardiac performance compares favorably to other “gold standards”, and expands on the ability to obtain a comprehensive cardiovascular exam. In recognition of the utility of intraoperative TEE for non-cardiac surgery, the ASA, SCA and National Board of Echocardiography have collaborated to develop a pathway for certification in basic perioperative TEE (www.echoboards.org). In addition, the “ECHO-in-ICU” group and the American College of Emergency Physicians have each proposed limited scope training guidelines for the focused use of echocardiography in the initial management of critically ill patients in the ICU and emergency room respectively. As the popularity of echocardiography increases and the indications for its perioperative utility evolves, appreciation for its value in the non-cardiac surgical population will continue to develop.

References


Disclosure

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