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# Feasibility of diagnosis of postcardiotomy tamponade by miniaturized transesophageal echocardiography



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## ABSTRACT

**Background:** Pericardial tamponade after cardiac surgery is a critical diagnosis that can be difficult to diagnose using conventional cardiac monitoring. Transesophageal echocardiography can provide comprehensive information to make the diagnosis but is not always available, whereas transthoracic echocardiography has its utility limited because of the body habitus or other surgical effects. New monitoring devices, miniaturized hemodynamic transesophageal echocardiography (hTEE), which allows point of care assessment of cardiac filling and functions, may aid in diagnosis of postcardiotomy tamponade.

**Methods:** From May 2011 to July 2013, 21 patients underwent hTEE to rule out pericardial tamponade for clinical suspicion of tamponade after open heart surgery. The hTEE images were reviewed, and the patient outcomes were analyzed.

**Results:** Nine patients showed no evidence of pericardial collection and did not require reexploration. Two patients showed a presence of small hematoma without ventricular compression and also did not undergo exploration. Ten patients were positive for pericardial tamponade (effusion or hematoma with ventricular compression); eight of these cases underwent emergent surgical exploration. Of the two patients who did not undergo immediate reoperation, one was managed by chest tube manipulation and the other patient underwent subsequent surgical exploration after his extensive coagulopathy was corrected by medical treatment.

**Conclusions:** The diagnosis of pericardial tamponade postcardiotomy is feasible using a disposable hTEE based on our limited experience. We avoided unnecessary explorations while concomitantly made prompt diagnosis in emergent situations. The hTEE device was a valuable tool in hemodynamic management in the intensive care unit, allowing rapid evaluations.

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## 1. Introduction

Postoperative cardiac surgery patients require extensive hemodynamic monitoring for potential life-threatening complications, pericardial tamponade being one of them. Postoperative pericardial tamponade requires expedient diagnosis and management to prevent unfavorable outcomes. The typical signs of pericardial tamponade are hypotension, low cardiac output, elevated filling pressure, and equalization of right-sided cardiac pressures on hemodynamics monitoring. If a patient develops obvious signs of tamponade after cardiac surgery, they need to undergo an emergent mediastinal exploration without any further imaging study. Any delay in reexploration can lead to fatal or nonfatal complications [1]. However, the diagnosis of pericardial tamponade is not always easy and sometimes requires additional imaging studies. Emergent explorations without definitive diagnosis may increase the number of negative explorations and increase the utilization of hospital resources substantially. Moreover, reexploration of the sternum, even if negative, increases mortality, morbidity, and length of stay [2]. Thus, it is important to have a clear indication of when surgical exploration is necessary and when not.

The standard imaging study to diagnose pericardial tamponade is transesophageal echocardiography (TEE), which provides comprehensive information about the pericardial space, ventricular volume, and function. TEE requires equipment and qualified personnel to perform the study; thus, it often limits the use of TEE in an intensive care unit (ICU), especially during off-hours and emergent situations. Trans-thoracic echocardiography may be more easily accessible in the ICU; however, it may not be able to provide enough information to diagnose pericardial tamponade because of body habitus, surgical tubes, edema from surgery, and mechanical ventilation.

Recently, FDA approved a disposable miniaturized (probe size 5.5 mm diameter) hemodynamic TEE (hTEE; ImaCor, Garden City, NY). This device has been used for the management of critically ill patients in ICU. Trained intensivists can insert and interpret hTEE finding for clinical decision making. This probe provides focused information of the cardiac filling and ventricular functions [3], which might be adequate to diagnose pericardial tamponade. In this study, we investigated the feasibility of the diagnosis of the pericardial tamponade by hTEE among early postcardiac surgery patients.

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## 2. Methods

From May 2011 through July 2013, a total of 584 patients were admitted to our surgical ICU after cardiac surgery (270 isolated coronary artery bypass graft [CABG], 52 CABG with valve combined, 174 valve, 23 heart transplant, 29 ventricular assist device placement, and 36 other cardiac procedures). hTEE probe was used for hemodynamic monitoring in addition to the conventional Swan-Ganz monitoring in high-risk patients. The hTEE was performed under mild sedation used after cardiac surgery without additional sedation or paralysis while the patients were still intubated. The hTEE images were

performed and read by the trained intensivists without consulting cardiology or radiology. Their training included didactic lectures, mannequin training, and hands-on experience with patients with trained personnel. The probe was removed after each study unless continuous monitoring was required. The diagnoses were made based on the image results with other hemodynamic data, and appropriate intervention was initiated at the time of the hTEE.

Institutional Review Board approved retrospective study of hTEE imaging. The images stored in the console were retrieved, and medical records were reviewed to identify the hTEE studies performed to rule out early pericardial tamponade within 72 h after surgery (early postoperative period). The patient demographics and hemodynamic parameters were also obtained from the medical record. During the study period, hTEE imaging was performed on 129 patients for various indications. Out of the 129 patients, 21 patients underwent hTEE to rule out pericardial tamponade with a high clinical suspicion of early postoperative tamponade, which included unexplained hypotension, elevated filling pressures, and low cardiac output.

Positive tamponade finding was defined as the presence of a pericardial collection (effusion or hematoma) compressing the ventricle. Negative finding was defined as no pericardial collection. If there was a pericardial collection but no ventricular compression, the case was individually evaluated by the intensivists and surgical team.

The patients who had hTEE done to rule out pericardial tamponade were divided into two groups: with tamponade based on hTEE (Group 1) and without tamponade based on hTEE (Group 2). Cardiac parameters and chest tube output 4 h before hTEE study were compared between the two groups. The endpoint of this study was surgical exploration performed during the same admission period from the primary surgery. In addition to that, hospital survivals in these patients who were suspected for tamponade were studied. Statistical comparisons between the two groups were performed using chi-squared test or Fisher exact test for categorical variables, and Student t-test for continuous variables. *P* values <0.05 were considered to be statistically significant.

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## 3. Results

The hTEE examinations were performed in 21 patients to rule out the clinical suspicion of pericardial tamponade. The trigger event for performing hTEE was hemodynamic instability (low cardiac output, elevated central venous pressure, and hypotension) without appropriate explanation in 18 patients and unexplained high chest tube output in three patients. The demographics of these patients were 17 males and four females, with a mean age of  $61 \pm 15$  y (Table 1). The primary surgical procedures were isolated CABG, isolated valve, or combined CABG and valve ( $n = 9$ ), heart transplant ( $n = 3$ ), type A dissection ( $n = 6$ ), ventricular assist device placement ( $n = 2$ ), and ventricular septal defect repair ( $n = 1$ ).

In nine patients (43%), hTEE was negative for pericardial effusion and diagnosis of tamponade was ruled out. These patients were further worked up for other entities on the

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