J Anesth (2009) 23:108–110
DOI 10.1007/s00540-008-0702-7

Journal of
Anesthesia

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Clinical reports

Usefulness of transesophageal echocardiography for identifying the precise location of a left ventricular rupture in a patient with collapsed cardiac chamber

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Abstract
We report an emergent case of cardiac tamponade due to rupture of the left ventricle. Preload and intracardiac volume were decreased by percutaneous cardiopulmonary support (PCPS), which led to the collapse of the cardiac chamber. The collapsed cardiac chamber made it difficult to diagnose cardiac abnormalities by preoperative transthoracic echocardiography (TTE). On loading fluid infusion and transfusion as volume load to improve the hemodynamic status, transesophageal echocardiography (TEE) revealed several leakages in the left ventricular myocardium. Continuous careful observation on TEE led us to a confident diagnosis of left ventricular rupture. The diagnosis by TEE also led to the employment of the appropriate procedure. TEE is useful for detecting an abnormality due to the location of the cardiac chamber and echocardiographic probe. We also note that continuous careful observation led to the employment of the appropriate procedure.

Key words Transesophageal echocardiography · Percutaneous cardiopulmonary support · Left ventricular rupture

Introduction

The use of transesophageal echocardiography (TEE) during surgery was first described in 1980. The improved quality of the acoustic image enabled anesthesiologists to diagnose myocardial ischemia, confirm the adequacy of valve reconstruction and other surgical repairs, determine the causes of hemodynamic disorders and other intraoperative complications, and provide diagnostic information that could not be obtained preoperatively. In the perioperative management of cardiac surgeries, percutaneous cardiopulmonary support (PCPS) is also beneficial for reducing the right ventricular preload and left ventricular workload, although PCPS potentially entails several risks such as leg ischemia, systemic inflammatory response, and vascular injury in the insertion of the cannula. At times when patients urgently need PCPS, there is often very limited information about their cardiac condition. It is difficult to diagnose cardiac abnormalities by transthoracic echocardiography (TTE) when cardiac chambers have collapsed under PCPS or cardiopulmonary bypass (CPB).

We report an emergent case of cardiac tamponade due to rupture of the left ventricle in a patient with PCPS, and difficulties in obtaining the diagnoses of cardiac abnormality. TEE was useful for detecting abnormality due to the location of the cardiac chamber and echocardiographic probe when the cardiac chamber had collapsed. A precise diagnosis was taken into consideration when determining the appropriate strategy for surgical intervention.

Case report

A 72-year-old woman, weight 40 kg and height 150 cm, was transferred to a critical care center. She was still conscious when she arrived at the center, with a Glasgow coma scale score of 11. Electrocardiogram showed elevated ST on II, III and aVf. TTE revealed cardiac tamponade. After general examination, cardiac arrest suddenly occurred. After cardiopulmonary resuscitation was performed, she received PCPS and was intubated for respiratory management. The duration of the cardiac arrest was about 7 min. She was immediately transferred to our hospital because of the necessity for surgical treatment. TTE still revealed cardiac tamponade without aortic dissection. On admission, although TTE could no longer detect cardiac abnormalities, except for cardiac effusion and reduction of myocardial contractility, and an electrocardiogram did not show

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Received: July 1, 2008 / Accepted: September 29, 2008

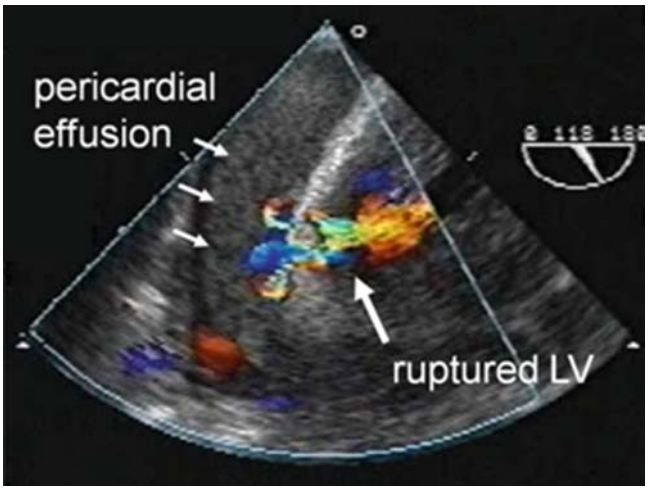

Fig. 1. Mid-esophageal long-axis view of left ventricle (*LV*) with color flow Doppler

any ST change in any leads, we suspected rupture of the left ventricle due to myocardial infarction.

When she arrived in the operation room under sedation, mean blood pressure was maintained at 50 mmHg and heart rate was 100 beats·min^{-1}. In spite of there being no pulsation pressure, the total flow of PCPS was maintained at only 0.5 l·min^{-1} because of her hypovolemic condition. We immediately started fluid infusion and transfusion intravenously. After obtaining adequate PCPS flow (2.0 l·min^{-1}), we induced general anesthesia. After the induction of general anesthesia, we placed a transesophageal multiplane probe (Philips Electronics, Eindhoven, Netherlands). TEE showed several leakages in the posterior wall of the left ventricle on color flow Doppler images in the mid-esophageal long-axis view (Fig. 1). Leaks were large enough to observe the colored leakage flow. Cardiac effusion was also revealed by compressing the right atrium and ventricle. We diagnosed the cause of cardiac tamponade to be rupture of the left ventricle. As a result, the effusion had caused complete diastolic collapse of the cardiac chamber. The right ventricular free wall could be seen completely indented toward the septum. At that moment, blood pressure and central venous pressure were maintained at 80/45 mmHg with pulsation and 21 mmHg, respectively. The visible leakages in the left ventricular myocardium shown by TEE were larger than we had expected. The planned drainage was expected to be ineffective, because drainage would have inevitably caused an increase in uncontrollable bleeding. We suggested that the surgeons repair the left ventricle under cardiac arrest with CPB.

After opening the pericardium, systolic blood pressure immediately decreased from 80 mmHg to 30 mmHg and central venous pressure decreased from 21 mmHg to 0 mmHg due to hemorrhage. To repair the rupture of the left ventricle, PCPS was suspended and CPB was quickly established. After the left ventricle was repaired, an intraaortic balloon pump was inserted. Normal contractility of the left ventricle was maintained and there were no ST changes in any leads. Weaning from CPB was uneventful. The postoperative course was uncomplicated. The physiological diagnosis of myocardial tissue showed necrosis and we diagnosed that acute myocardial infarction had occurred. Sixty days after the surgery, coronary angiography revealed 75% stenosis in the right coronary artery, and left anterior descending branch. The stenosis in the right coronary artery was suspected to be the responsible lesion. However, no coronary artery intervention was performed because of the normal contraction of the left ventricle.

Discussion

Cardiopulmonary support systems are generally used for hemodynamic stabilization. In some emergency cases in patients receiving PCPS, there is only very limited information on the patients. In addition to computed tomography and magnetic resonance, echocardiography is helpful for confirming diagnoses in patients with severe hemodynamic instability. In contrast, intraoperative TEE examination has been widely used for detecting cardiac abnormalities. TEE has caused complications that are primarily associated with esophageal intubation. These include trauma to the esophagus, causing odynophagia; esophageal perforation; and upper gastrointestinal bleeding [1]. The risk of bleeding with PCPS or CPB can be higher under conditions of heparinization. According to the American Society of Echocardiography/Society of Cardiovascular Anesthesiologists (ASE/SCA) practice guidelines, TEE examination can frequently lead to improved patient outcomes [2]. Although other intraoperative monitoring devices can provide some information, TEE offers important advantages over other diagnostic monitoring techniques. For example, intraoperative echocardiograms can be obtained by TTE or, if the chest is open, by epicardial echocardiography. However, the acoustic images of TTE are generally poorer than those of TEE, and monitoring must be discontinued if the chest is opened or if surgical equipment, drapes, or monitors block access to the chest [3].

Left ventricular rupture is a life-threatening complication of myocardial infarction. Matsukawa et al. [4] reported that left ventricle repair without coronary revascularization did not improve left ventricular function. We did not perform additional bypass grafting because of the lack of time for coronary angiography and coronary computed tomography, due to the patient's critical condition. Although repair of the ventricle

rupture without coronary bypass grafting might have caused hemodynamic deterioration after surgery, we did not perform additional bypass grafting during the operation because myocardial contractility in the residual myocardial area was shown to be normal by TEE. In fact, despite our expectation, postoperative coronary angiography did not demonstrate any severe stenosis in any coronary arteries.

Deshmukh et al. [5] reported that TEE was superior to TTE because of the better delineation of myocardial structures, especially the ventricular wall, particularly in cases suspected of inferior or posterior wall rupture, because transthoracic images are difficult to obtain and may be inadequate in seriously ill patients. We supposed that decreased preload had caused the equivocal intracardiac diagnosis indicated by echocardiography. Intraoperative TEE is useful for obtaining a clear view of the posterior wall of the left ventricle because the TEE probe is positioned posterior to the left atrium at the mid level of the mitral valve.

In our patient, preload and intracardiac volume were decreased by the necessity for an additional volume for PCPS, which led the cardiac chamber to collapse. A collapsed cardiac chamber could make diagnosis by preoperative TTE difficult. In regard to echographic techniques, several techniques are required for optimizing transesophageal images. First, it is very important to have the color gain set properly. If the gain is set too low, a small jet can be missed. Second, the color scale which affects the Nyquist limit has to be decreased when lower-flow velocities are detected. Adjusting the color scale to produce aliasing intentionally is required to detect velocities. Finally, three-dimensional TEE may also be useful to make a diagnosis of left ventricular rupture. Nekkanti et al. [6] reported the superiority of three-dimensional TEE over two-dimensional TEE to make the diagnosis of combined left ventricular pseudoaneurysm and ventricular septal rupture. In addition to echographic techniques, continuous careful observation on TEE led us to a confident diagnosis of the left ventricular rupture in our patient, and then the planned surgical procedure was altered appropriately. In this patient, we immediately started adequate fluid infusion and transfusion intravenously just before the induction of general anesthesia. Adequate infusion and transfusion must be timely and effective for obtaining a diagnosis by TEE.

In conclusion, intraoperative TEE was useful in identifying the precise location of a left ventricular rupture; we note that it is important to give adequate fluid infusion for obtaining a precise diagnosis by this method. Furthermore, postoperative TEE was also useful in confirming the normal ventricular wall motion.

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