

- A diagnostic aid for Lambert-Eaton myasthenic syndrome. *Mayo Clin Proc* 64:1498-1504, 1989
- Lambert EH, Eaton LM, Rooke ED: Defect of neuromuscular conduction associated with malignant neoplasm. *Am J Physiol* 187:612-613, 1956
 - Lambert EH, Elmquist D: Quantal components of end-plate potentials in the myasthenic syndrome. *Ann NY Acad Sci* 183: 183-199, 1971
 - Lambert EH, Rooke ED, Eaton LM, Hodgson CH: Myasthenic syndrome occasionally associated with bronchial neoplasm: Neurophysiological studies, *Myasthenia Gravis*. Edited by Viets HR. Springfield, IL, Charles C. Thomas, 1961, pp 326-410
 - Rooke ED, Eaton LM, Lambert EH, Hodgson CH: Myasthenia and malignant intrathoracic tumours. *Med Clin North Am* 44: 977-988, 1960
 - O'Neill JH, Murray NMF, Newsom-Davis J: The Lambert-Eaton myasthenic syndrome: A review of 50 cases. *Brain* 3:577-596, 1988
 - Ward CD, Murray NMF: Effect of temperature on neuromuscular transmission in the Eaton-Lambert syndrome. *J Neurol, Neurosurg Psychiatry* 42:247-249, 1979
 - Newsom-Davis J, Murray NMF: Plasma exchange and immunosuppressive drug treatment in the Lambert-Eaton myasthenic syndrome. *Neurology (Cleveland)* 34:480-485, 1984
 - Lang B, Newsom-Davis J, Wray D, Vincent A, Murray N: Autoimmune etiology for myasthenic (Eaton-Lambert) syndrome. *Lancet* 2:224-226, 1981
 - Lambert EH, Lennon VA: Selected IgG rapidly induces Lambert Eaton myasthenic syndrome in mice: Complement independence and EMG abnormalities. *Muscle Nerve* 11:1133-1145, 1988
 - Fukunaga H, Engel AG, Osame M, Lambert EH: Paucity and disorganization of presynaptic membrane active zones in the Lambert-Eaton syndrome. *Muscle Nerve* 5:686-697, 1982
 - Lang B, Newsom-Davis J, Prior C, Wray D: The effect of myasthenic syndrome antibodies on presynaptic calcium channels in the mouse. *J Physiol (Lond)* 390:257-270, 1987
 - Lennon VA, Lambert EH, Whittingham S, Fairbanks V: Autoimmunity in the Lambert-Eaton myasthenic syndrome. *Muscle Nerve* 5:S21-S25, 1982
 - Roberts A, Perera S, Lang B, Vincent A, Newsom-Davis J: Paraneoplastic myasthenic syndrome IgG inhibits Ca influx in a human small cell carcinoma line. *Nature* 317:737-739, 1985
 - Yoshikami D, Bagabaldo Z, Olivera BM: The inhibitory effects of Omega-contoxins on Ca channels and synapses. *Ann NY Acad Sci* 560:230-248, 1989
 - DeAizpurua HJ, Lambert EH, Griesmann GE, Olivera BM, Lennon VA: Antagonism of voltage-gated calcium channels in small cell carcinoma of patients with and without Lambert-Eaton myasthenic syndrome by autoantibodies w-conotoxin and adenosine. *Cancer Res* 48:4719-4724, 1988
 - Wise RP: A myasthenic syndrome complicating bronchial carcinoma. *Anesthesia* 17:488-504, 1962
 - Churchill-Davidson HC: Muscle relaxants. *Recent Advances in Anesthesia and Analgesia*. Edited by Langton Hewer C. Boston, Little Brown & Co., 1963, pp 79-110
 - Brown JC, Johns RJ: Diagnostic difficulties encountered in the myasthenic syndrome sometimes associated with carcinoma. *J Neurol Neurosurg Psych* 37:1214-1224, 1974
 - Brown JC, Charlton JE: A study of sensitivity to curare in myasthenic disorders using a regional technique. *J Neurol Neurosurg Psych* 38:27-33, 1975
 - Telford FJ, Hollway TE: The myasthenic syndrome: Anaesthesia in a patient treated with 3,4 diaminopyridine. *Br J Anaesth* 64: 363-366, 1990

Detection of Occult Hemopericardium Using Intraoperative Transesophageal Echocardiography

MARK M. MITCHELL, M.S., M.D.*

CASE REPORT

Transesophageal echocardiography (TEE) has been shown to be useful for intraoperative evaluation and monitoring of patients who have suffered major trauma.^{1,2} The following is a report of a case in which intraoperative TEE detected an otherwise occult hemopericardium.

A 35-yr-old otherwise healthy man presented with a stab wound in the left upper quadrant of the abdomen. He was alert and hemodynamically stable and had no other injuries. Supine chest x-ray showed no pneumothorax, hemothorax, or widening of the mediastinum. Transthoracic echocardiography (TTE) was not available in the trauma resuscitation area. He was brought on an emergency basis to the operating room for diagnostic peritoneal lavage and exploration of the wound. Anesthesia was induced with thiopental and the trachea intubated after administration of succinylcholine. Upon inspection of the pharynx and passage of an oral-gastric tube, no blood was found, and trauma to the stomach and esophagus was assessed as unlikely. In addition, no blood was found by peritoneal lavage, and it was decided that exploratory laparotomy was not indicated.

* Professor of Anesthesiology.

Received from the Department of Anesthesiology, University of California San Diego, San Diego, California.

Address reprint requests to Dr. Mitchell: Department of Anesthesiology, University of California San Diego Medical Center, 225 Dickinson Street, San Diego, California 92103-1990.

Key words: Heart: hemopericardium; pericardium; tamponade; trauma. Measurement techniques: Transesophageal echocardiography.

There was still some concern about the possibility of intrathoracic injury because of the location of the wound, but the patient remained

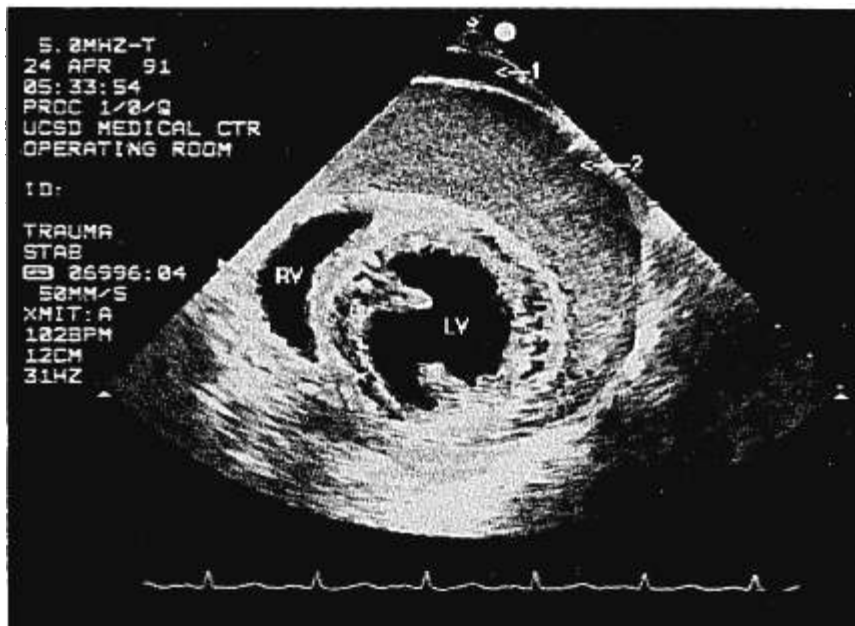


FIG. 1. Hemopericardium. A short-axis TEE view of the left ventricle (LV) and right ventricle (RV), which also shows a 150-ml hemopericardium at arrow 2 and some peritoneal fluid below the diaphragm at arrow 1.

hemodynamically stable, with a heart rate of 110 beats/min, blood pressure of 120/70 mmHg with a systolic variation of 8–12 mmHg with positive pressure ventilation, and a central venous pressure of 11–13 mmHg. The electrocardiogram showed only sinus tachycardia. If an exploratory laparotomy had been indicated, protocol would have required a transdiaphragmatic exploration of the pericardial space.³ A subxiphoid pericardotomy was not performed because of the low expected diagnostic yield in patients with stable vital signs.³ Plans were made to terminate the anesthetic, extubate his trachea, and return him to the intensive care unit for continued observation.

During closure of the peritoneal lavage incision a Hewlett-Packard monoplane 5.0-MHz TEE probe was placed because the location of the wound suggested the possibility of intrathoracic trauma. It was connected to a Hewlett-Packard Sonus 500L ultrasound imaging system (Hewlett-Packard, Andover, MA). A hemopericardium was seen in the transgastric short axis view, as shown in figure 1. Some fluid retained from the peritoneal lavage was also seen in the subdiaphragmatic region. Configuration and motion of the interatrial septum, interventricular septum, right atrium, and right ventricular free wall were normal and consistent with the absence of tamponade related hemodynamics. When completion of the peritoneal lavage allowed access to the precordium, the hemopericardium was confirmed by subxiphoid TTE, after which a median sternotomy was performed, and 150 ml of clotted blood was removed from the pericardium. A 10-mm-long, 1–2-mm-deep laceration of the surface of the right ventricle was oversewn.

The patient was returned to the intensive care unit. He recovered uneventfully and was discharged 4 days postoperatively.

DISCUSSION

This case suggests that intraoperative TEE can detect pericardial effusions that may be too small to cause tamponade but that might be an indication of potentially life-threatening intrapericardial trauma. Even acute pericardial accumulation of several hundred cubic centimeters may not produce clinical signs of tamponade.³ Timely

detection of hemopericardium as an indicator of intrapericardial trauma is essential in order to avoid subsequent complications such as delayed rupture of injured structures, progressive accumulation of intrapericardial fluid, and delayed onset of tamponade, or infection and abscess formation.⁴

Echocardiographic examination for suspected intrapericardial trauma not only is a sensitive detector of accumulated blood or fluid but also affords an opportunity for the assessment of ventricular filling and performance and detection of abnormal septal motion, right atrial or right ventricular free wall collapse, and reversal of diastolic blood flow in the superior vena cava indicative of significant existing or developing tamponade.^{1,5} TEE examination can also detect pleural fluid accumulation indicative of pulmonary, pleural, or chest wall injury, and myocardial morphologic distortion or dysfunction indicative of cardiac or pericardial injury.[†] TEE has an advantage over TTE in that it often can be accomplished intraoperatively when TTE cannot because of interference with the surgical field (as in the case that we report here); in addition, TEE image quality is usually better than is that with TTE.⁶ There are as yet no reports of complications relative to the use of TEE in patients with chest and abdominal trauma.⁷

† Orihashi K, Hong YW, Chung G, Sisto D, Goldiner PL, Oka Y: New applications of two-dimensional transesophageal echocardiography in cardiac surgery. *Journal of Cardiothoracic and Vascular Anesthesia* 5:33–39, 1991.

Experience with this case supports the utility of TEE in the evaluation of selected patients with penetrating chest and abdominal trauma and suggests that TEE may be a sensitive detector of even hemodynamically inconsequential pericardial fluid accumulations, which in turn may be indicative of significant intrapericardial injury.

REFERENCES

1. Whye D, Barish R, Almquist T, Groleau G, Tso E, Frown B: Echocardiographic diagnosis of acute pericardial effusion in penetrating chest trauma. *Am J Emerg Med* 6:21-23, 1988
2. Reid CL, Kawanishi DT, Rahimtoola SH, Chandraratna PA: Chest trauma: evaluation by two-dimensional echocardiography. *Am Heart J* 113:971-976, 1987
3. Jimenez E, Martin M, Krukenkamp I: Subxiphoid pericardiotomy versus echocardiography: A prospective evaluation of the diagnosis of occult penetrating cardiac injury. *Surgery* 108:676-680, 1990
4. Baillet R, Dontigny L, Verdant A, Vaillancourt R, Page A, Page P, Cossette R: Intrapericardial trauma: Surgical experience. *J Trauma* 29:736-740, 1989
5. Cohen ML: Experimental cardiac tamponade: Correlation of pressure, flow velocity, and echocardiographic changes. *J Appl Physiol* 69:924-931, 1990
6. Mitchell MM, Sutherland GR, Gussenhoven EJ, Taams MA, Roelandt JRTC: Transesophageal echocardiography: State-of-the-art technologies. *J Am Soc Echocardiogr* 1:362-377, 1988
7. Daniel WG, Erbel R, Kasper W, Visser CA, Engberding R, Sutherland GR, Grube E, Hanrath P, Maisch B, Dennig K, Scharl M, Kremer P, Angermann C, Iliceto S, Curtius JM, Mugge A: Safety of transesophageal echocardiography: A multicenter survey of 10,419 examinations. *Circulation* 83:817-821, 1991