

Perivalvular leakage after termination of cardiopulmonary bypass procedure

YUJI KADOI, HUMINORI KAWAHARA, and NAO FUJITA

Department of Anesthesiology, Saitama Prefectural Ohara-Cardiovascular Center, 1696 Itai Kounancyhou Osatogun, Saitama 360-01, Japan

Key words: Transesophageal echocardiography, Prosthetic valve dysfunction

Introduction

Although some claim that transesophageal echocardiography (TEE) should not be used routinely to monitor anesthesia for cardiac surgery [1], intraoperative TEE has been widely used by anesthesiologists in the operating room to evaluate cardiac function, myocardial ischemia, valve function, and adequacy of surgical repairs [2–5]. Therefore anesthesiologists are sometimes required to be cardiac diagnosticians when they do use TEE [5]. In the case reported here, we observed perivalvular regurgitation using the TEE monitor when cardiopulmonary bypass (CPB) was terminated after valve replacement, even though no traditional hemodynamic changes were observed.

Case report

A 62-year-old woman had had dyspnea on effort 4 years previously and was medicated with digoxin. On the current admission she was scheduled for mitral valve replacement (MVR) to correct severe mitral stenosis. A preoperative study by left ventriculoangiography showed that the ejection fraction was 59%, there was fourth-degree mitral valve stenosis, and the area of the mitral valve was 0.62 cm².

The patient was premedicated with 10 mg oral diazepam 1 h before surgery. Five electrodes were placed for electrocardiography (ECG), and the left ra-

dial artery was cannulated to monitor the arterial blood pressure. Anesthesia was accomplished by intravenous administration of fentanyl 10 µg·kg⁻¹, midazolam 0.1 mg·kg⁻¹, and vecuronium 8 mg; and the trachea was intubated. She received fentanyl 100 µg·kg⁻¹ and midazolam 0.2 mg·kg⁻¹ before the CPB was started. After the induction of anesthesia, a 5.0 MHz biplane transesophageal probe (UST-5253S-5, Aloka, Tokyo, Japan) was placed in the esophagus. Before the skin was incised an initial image was obtained with an Aloka 9900 imaging unit. A continuous cardiac output catheter (Vigilance, Swan-Ganz CCO Thermodilution Catheter; Baxter, Irvine, CA, USA) was positioned through the right internal jugular vein.

The CPB required 125 min. MVR was performed using a St. Jude mitral valve prosthesis (27 mm, model 27 M-101), and plasty of the papillary muscle and chordae was performed. The function of the prosthetic valve was evaluated after completion of the CPB. Perivalvular regurgitation (PVR) (length 1.6 cm, jet area 2.5 cm², dehiscence 0.33 cm) was observed (Figs. 1, 2), with the cardiac index at this time at 2.8 L·min⁻¹·sqm⁻¹. We informed the surgeons of this observation, and they inserted a catheter into the left atrium to determine the left atrial pressure (LAP). The mean LAP was 5 mmHg, with no abnormal V waves observed on the atrial or wedge pressure tracing. The surgeons touched the left atrium to palpate for a regurgitant thrill over the atrium, and none was found. The cardiologist was consulted, and he noted that the pathological PVR was minimal, although dehiscence was observed with TEE. He suggested that the PVR could cause thromboembolism or endocarditis. Therefore the mitral valve operation was continued and CPB recommenced. The surgeon found a 0.4-cm gap in the suture line at the location indicated by the regurgitation jet, and the gap was closed with sutures. The patient was extubated 12 h after the operation and discharged from the intensive care unit 2 days after the operation.

Address correspondence to: Y. Kadoi

Received for publication on June 18, 1996; accepted on January 6, 1997

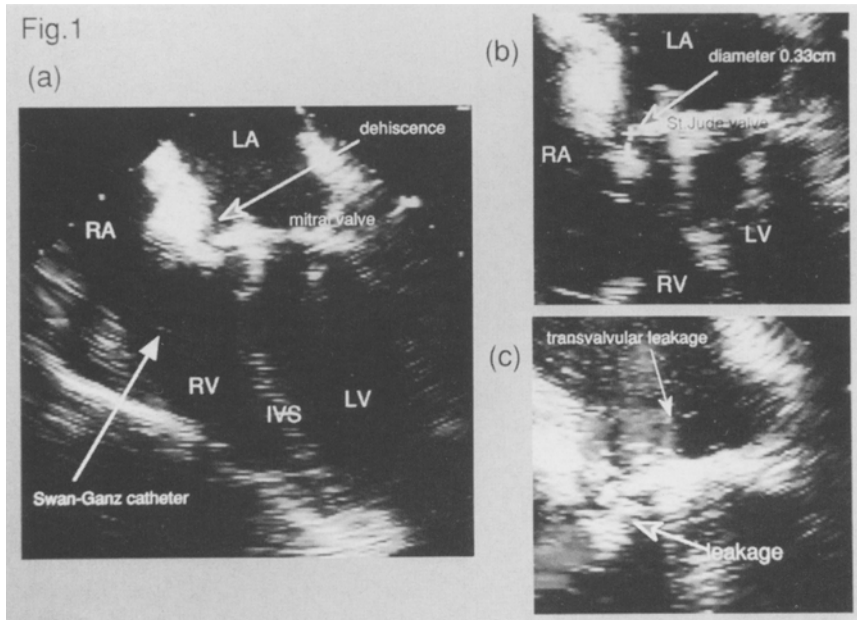


Fig. 1. (a) Transesophageal echocardiography (TEE) four-chamber view obtained in the horizontal plane when cardiopulmonary bypass was terminated after mitral valve replacement. This view was obtained by retroflexion of the endoscope tip about 32 cm from the incisors. The dehiscence was seen at the points indicated by arrows. (b) The diameter of dehiscence was 0.33 cm. (c) TEE color-flow imaging of mitral regurgitation at systole. Perivalvular leakage (PVR) was seen at the points indicated by arrows. Transvalvular leakage, which is normal, was also observed. The jet area of PVR was 2.5 cm². RA, right atrium; RV, right ventricle; LA, left atrium; LV, left ventricle; IVS, interventricular septum

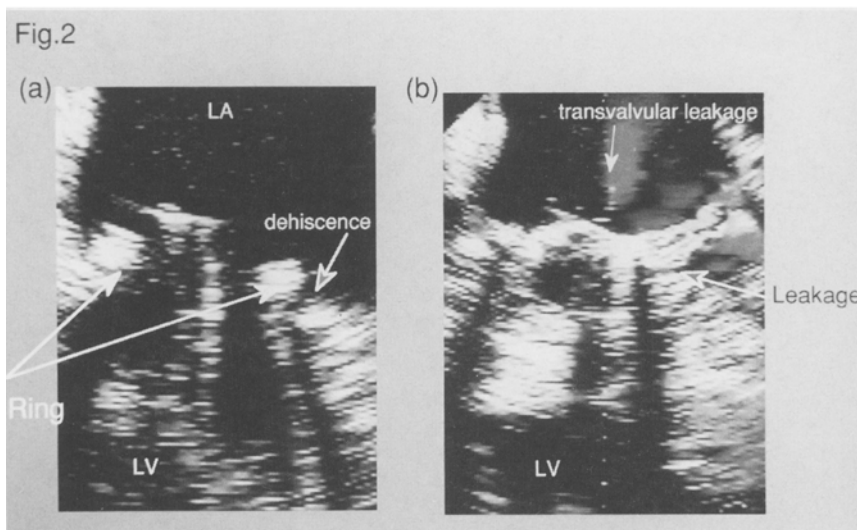


Fig. 2. TEE two-chamber views obtained in the longitudinal plane. (a) Both leaflets of the St. Jude mitral valve were in open position during diastole. An echocardiographic artifact obscures the cardiac structures on the left ventricular side of the mitral valve prosthesis. The suture ring of the St. Jude mitral prosthesis was seen at the points indicated (white arrowheads). The dehiscence was also seen at the outside of the ring (gray arrowhead). (b) TEE color-flow imaging of mitral regurgitation at systole. Perivalvular leakage was seen at the points indicated (arrows). LA, left atrium; LV, left ventricle

Discussion

Residual prosthetic valve regurgitation after valve reconstitution is associated with various postoperative complications such as thromboembolism, hemolysis, endocarditis, and low cardiac output syndrome [6–8]. Therefore it is important to evaluate the function of the valve prosthesis after replacement. TEE is one of the most reliable tools for such assessment [8]. If the TEE monitor had not been used in our case, residual regurgitation might not have been detected during the perioperative period, as no abnormalities in the traditional hemodynamic parameters were observed. Thus we consider the TEE monitor essential for evaluating prosthetic valve function after CPB.

Transesophageal echocardiography has been widely used by anesthesiologists in the operating room, not only as a monitor of cardiac function but also as a diagnostic tool [4,5]. Hodgins et al. recommended collaboration, completeness, and competence on the part of the anesthesiologist-echocardiographer when TEE is used by anesthesiologists in the operating room [4]. Hence in our case we consulted a cardiologist about whether further surgery was necessary. As the PVR was minimal but dehiscence was observed on TEE, the anesthesiologist, cardiologist, and surgeons agreed that the dehiscence could cause thromboembolism or endocarditis despite the small amount of regurgitation. Moreover, the degree of regurgitation might be underestimated, as the jets were

usually eccentric, striking the atrial wall (Coanda effect) [9].

The PVR jets can be differentiated from physiologic jets in patients with St. Jude valve replacements, as they characteristically consist of two to four small, low-turbulence jets originated from within the valve ring [10]. Regurgitation is considered to be perivalvular if a turbulent eccentric jet originates outside the prosthetic suture ring or a perivalvular gap is visualized between the anulus and the suture ring [10].

Whether to repair minimal PVR (jet area $<3.0\text{cm}^2$) found at the time of surgery is controversial [11,12]. PVR is relatively common and the correct clinical response somewhat uncertain. Most authorities believe that small leaks are best left alone and should not undergo further surgery [12], but there are no definitive studies in this area [11]. Lange et al. reported that clinically significant PVR should be suspected if the maximum jet length exceeds 3.0cm [10]. Meloni et al. also reported that a small PVR (jet area $<3.6\text{cm}^2$) should be left alone [12]. However, Movsowitz et al. claimed that mild PVR should be repaired if it can be done at low risk, because some small residual regurgitations are progressive [11].

Our case suggests that it may be difficult to decide whether to undergo further surgery when minimal PVR is observed soon after the termination of CPB owing to the fact that there have been no definitive studies in this area. In such cases it is essential for the anesthesiologist to collaborate with the surgeons and a cardiologist. This case report suggests that anesthesiologists should be required to have an advanced level of training to achieve proficiency if they use TEE to monitor patients perioperatively.

References

1. Bondy R, Ralley F (1993) TEE is not a routine monitor in anesthesia for cardiac surgery. *J Cardiothorac Vasc Anesth* 7:361–363
2. Sutton DC, Cahalan MK (1993) TEE is a routine monitor. *J Cardiothorac Vasc Anesth* 7:357–360
3. Konstadt S, Reich DL, Thys DM, Aronson S (1993) Transesophageal echocardiography. In: Kaplan JA (ed) *Cardiac anesthesia*. 3rd edn. Saunders, Philadelphia, pp 342–385
4. Hodgins L, Kisslo JA, Mark JB (1995) Perioperative transesophageal echocardiography. *The anesthesiologist as cardiac diagnostician*. *Anesth Analg* 80:4–6
5. Poterack KA (1995) Who uses transesophageal echocardiography in the operation room? *Anesth Analg* 80:454–458
6. Czer LSC, Maurer G, Bolger AF, De Robertis M, Resser KJ, Kass RM, Lee ME, Blanche C, Chaux A, Gray RJ, Matloff JM (1987) Intraoperative evaluation of mitral regurgitation by Doppler color flow mapping. *Circulation* 76 [suppl 3] 3:108–116
7. Sheikh KH, Bruijn NP, Rankin JS, Clements FM, Stanley T, Wolfe WG, Kisslo J (1990) The utility of transesophageal echocardiography and Doppler color flow imaging in patients undergoing cardiac valve surgery. *J Am Coll Cardiol* 15:363–372
8. Khandheria BK, Seward JB, Oh JK, Freeman WK, Nichols BA, Sinak LJ, Miller Jr FA, Tajik AJ (1991) Value and limitations of transesophageal echocardiography in assessment of mitral valve prostheses. *Circulation* 83:1956–1968
9. Missri J (1993) *Transesophageal echocardiography. Clinical and intraoperative application*. Churchill Livingstone, New York, pp 71–80
10. Lange HW, Olson JD, Pedersen WR, Kane MA, Daniel JA, Mooney MR, Goldenberg IF (1991) Transesophageal color Doppler echocardiography of the normal St. Jude medical mitral valve prosthesis. *Am Heart J* 122:489–494
11. Movsowitz HD, Shah SI, Ioli A, Kotler MN, Jacobs LE (1994) Long-term follow-up of mitral paraprosthetic regurgitation by transesophageal echocardiography. *J Am Soc Echocardiogr* 7:488–492
12. Meloni L, Aru G, Abbruzzese PA, Cardu G, Ricchi A, Cattolica SL, Martelli V, Cherchi A (1994) Regurgitant flow of mitral valve prostheses. An intraoperative transesophageal echocardiographic study. *J Am Soc Echocardiogr* 7:36–46