

CASE REPORTS

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Simultaneous Transesophageal Echocardiography and Atrial Pacing for Intraoperative Management of Mitral Regurgitation

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MITRAL regurgitation (MR) leads to left atrial pressure elevation and volume overload. To prevent increases in the regurgitant volume and associated decreases in cardiac output, bradycardia and hypertension should be prevented. Smith *et al.*¹ and Tomichuk *et al.*² reported that transesophageal atrial pacing is a more rapid and reliable technique than pharmacologic intervention for the treatment of intraoperative bradycardia. In addition, Lambertz *et al.*,³ Kamp *et al.*,^{4,5} and Hogue *et al.*⁶ recently demonstrated that pacing-induced tachycardia with simultaneous transesophageal echocardiographic (TEE) monitoring is useful to detect left ventricular wall motion abnormalities with rapid pacing. Based on these reports, we performed simultaneous transesophageal atrial pacing and TEE monitoring in a patient undergoing mitral valve repair to monitor and correct hemodynamic deterioration associated with bradycardia.

Case Report

A 61-yr-old man (height, 170 cm; weight, 80 kg) with MR was scheduled for mitral valve repair surgery. Medical history included bacterial endocarditis 3 months before surgery and hypertension. Except for a systolic murmur (Levine III/VI), no remarkable physical findings were present. Laboratory values were unremarkable. Electrocardiography revealed normal sinus rhythm and left ventricular hyper-

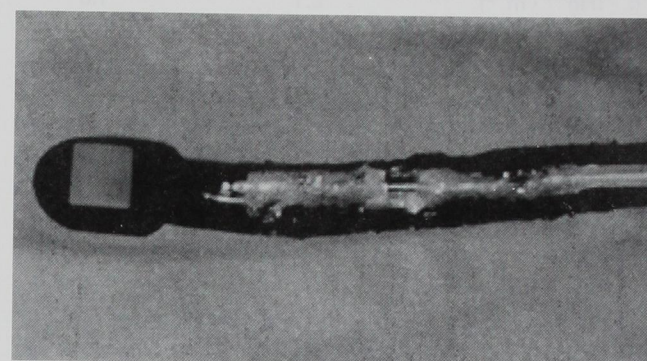


Fig. 1. A bipolar pacing lead with an interelectrode distance of 22 mm was attached to a transesophageal echocardiographic (TEE) probe and covered with a thin layer of silicone. The distal electrode was placed 25 mm from the tip of the TEE probe.

trophy. Preoperative echocardiography showed severe MR resulting from prolapse of the posterior mitral valve leaflet and chordal rupture.

Our protocol was approved by The Ethical Committee on Human Study, and written informed consent was obtained from the patient. The patient was premedicated with atropine and hydroxyzine 30 min before induction of anesthesia. Anesthesia was induced with fentanyl and thiopental and maintained with fentanyl, sevoflurane, and nitrous oxide. Muscle relaxation was obtained with vecuronium. After tracheal intubation, a pulmonary artery catheter was placed through the right internal jugular vein. A bipolar pacing lead with an interelectrode distance of 22 mm (5824A; Medtronic, Anaheim, CA) was fixed to the TEE probe with silicone adhesive (080118; Dow Corning, Midland, MI). The distal electrode was placed 25 mm from the tip of the TEE probe (fig. 1) and used as the cathode. The pacing lead was connected to a pulse generator (SEN-3201 and SS-104J; Nihon Kohden, Tokyo, Japan). A 5.0-MHz single-plane TEE probe (UST-5228 BS-5; Aloka, Tokyo, Japan) with pacing lead was inserted atraumatically into the esophagus.

After the start of surgery, heart rate decreased gradually to less than 50 beats/min. Systolic arterial blood pressure, which was 130 to 140 mmHg preoperatively, decreased to 80 to 90 mmHg. The TEE probe was positioned to obtain a long-axis three-chamber view and then was moved slightly until pacing threshold current was minimal; in this case, 10.1 mA at stimulus duration of 10 ms. Because TEE was also used to monitor cardiac function, pacing was performed using pulses of 20% more than the threshold current (12.1 mA) to achieve stable atrial capture during manipulation of the TEE probe. Bipolar pacing was initiated at a rate of 100 beats/min. Atrial capture was confirmed by electrocardiography, direct arterial pressure recording, and TEE monitoring. Pacing was maintained for 40 min until the initiation of car-

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Table 1. Hemodynamic Variables Recorded before (with Pacing) and during the Interruption of Pacing (without Pacing)

	With Pacing	Without Pacing
HR (beats \cdot min ⁻¹)	100	58
ABP (mmHg) S/D (M)	113/72 (88)	102/61 (76)
PAP (mmHg) S/D (M)	24/11 (18)	25/12 (19)
PCWP (mmHg)	9	12
CVP (mmHg)	5	7
CO (L \cdot min ⁻¹)	4.1	3.0
CI (L \cdot min ⁻¹ \cdot m ⁻²)	2.1	1.6
SVI (ml \cdot beat ⁻¹ \cdot m ⁻²)	21.4	26.9
SVR (dyne \cdot s \cdot cm ⁻⁵)	1620	1840

HR = heart rate; ABP = arterial blood pressure; S = systolic; D = diastolic; M = mean; PAP = pulmonary arterial pressure; CVP = central venous pressure; PCWP = pulmonary capillary wedge pressure; CO = cardiac output; CI = cardiac index; SVI = stroke volume index; SVR = systemic vascular resistance.

diopulmonary bypass. To assess the usefulness and efficacy of pacing for the treatment of sinus bradycardia and hypotension, hemodynamic parameters and TEE images were recorded simultaneously before and during the temporary interruption of pacing.

Cardiac output and pulmonary arterial pressure were directly measured, whereas cardiac index, stroke volume index, and systemic vascular resistance were calculated using standard formulae. The width and the length of mitral regurgitant jet, proximal isovelocity surface area of the flow convergence region proximal to the regurgitant orifice,^{7,8} and pulmonary venous flow^{9,10} were evaluated using Doppler color flow mapping and pulsed Doppler echocardiography. An eccentric MR jet was imaged during each systole. Hemodynamic variables recorded before (with pacing) and during the interruption of pacing (without pacing) are summarized in the table 1. The interruption of pacing resulted in a decrease in heart rate, arterial blood pressure, and cardiac index and in an increase in pulmonary capillary wedge pressure, stroke volume index, and systemic vascular resistance. Although interruption of pacing did not significantly change the width or the length of the mitral regurgitant jet, the radius of the proximal isovelocity surface area increased from 0.8 to 1.2 cm (fig. 2). Compared with the pulmonary venous flow pattern recorded during pacing, interruption of pacing increased the magnitude of the early diastolic D wave and decreased the magnitude of the systolic S wave (fig. 3). The remainder of the operative course was uneventful.

Discussion

It has been reported that transesophageal atrial pacing is useful for the treatment of intraoperative bradycardia and hypotension for those settings in which atrioventricular conduction is intact.¹¹⁻¹³ In these previous studies, a pacing esophageal stethoscope was used. In contrast, we used a bipolar pacing lead attached to the TEE probe. Although pacing-induced tachycardia with simultaneous TEE monitoring has been reported to be useful in the

detection of coronary artery disease in conscious patients,³⁻⁵ we are unaware of any studies of the usefulness and efficacy of simultaneous transesophageal atrial pacing and TEE monitoring for the treatment of sinus bradycardia and hypotension in patients with MR. Compared with a pacing esophageal stethoscope, our device might be superior for two reasons. First, positioning of the pacing lead is easy and rapid because the left atrium can be visualized using TEE. In our experience, threshold current is minimal at or near the long-axis three-

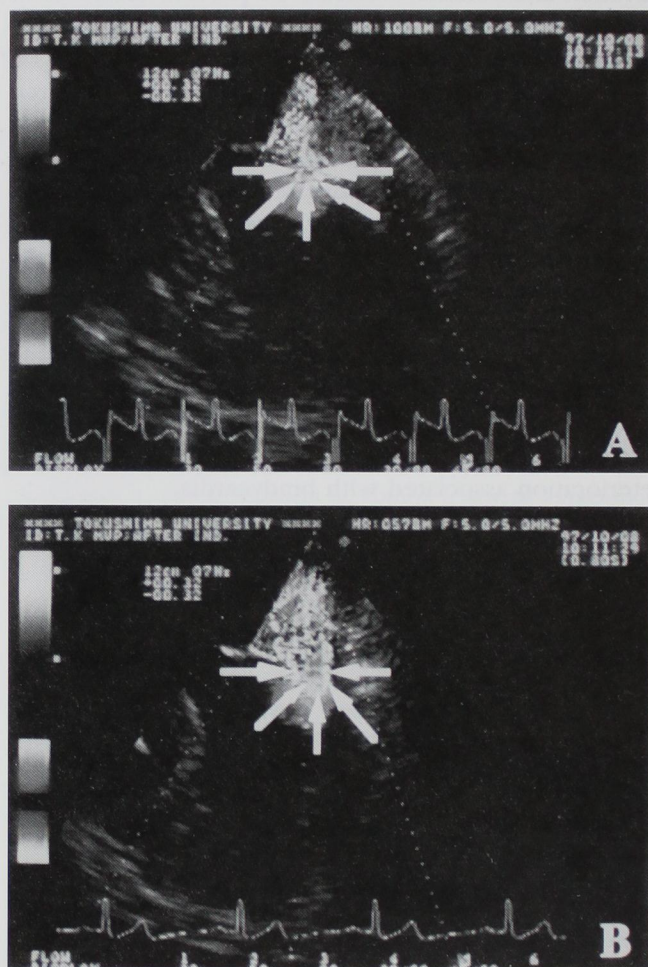


Fig. 2. Color Doppler echocardiographs obtained from the long-axis three-chamber view. The proximal isovelocity surface area of the flow convergence region proximal to the regurgitant orifice is identified by the color reversal from red to blue along the first aliasing border (arrow) for blood flow toward the mitral valve. The first aliasing occurred at a flow velocity of 32 cm/s. The radius of the proximal isovelocity surface area, which was defined as the distance between the first aliasing border and the regurgitant orifice, was 0.8 cm during pacing (A), whereas it was 1.2 cm when pacing was discontinued temporarily (B).

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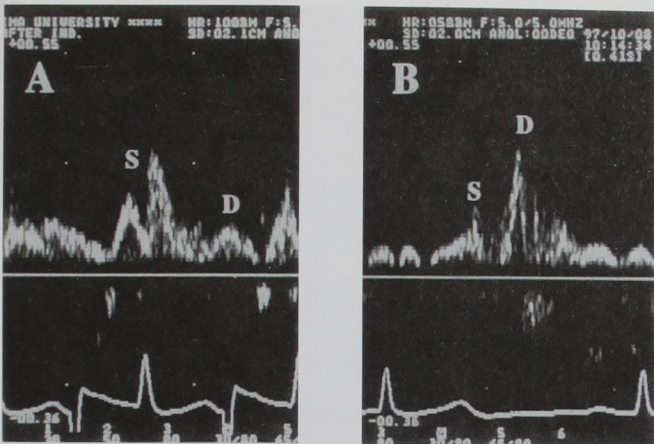


Fig. 3. Pulmonary venous flow patterns recorded during (A) and after (B) the interruption of pacing. Note that, compared with the pulmonary venous flow patterns recorded during pacing, the amplitude of the early diastolic D wave increased and the amplitude of the systolic S wave decreased when pacing was discontinued.

chamber view points. In contrast, when a pacing esophageal stethoscope is used, esophageal P waves must be recorded or the optimal depth of the probe must be calculated based on the patient's height.¹³ Second, in our device, stable atrial capture can be obtained during manipulation of the TEE probe. Hesselvik *et al.*¹⁴ studied the effects of inserting the TEE probe on the pacing threshold of a previously inserted pacing esophageal stethoscope and revealed that performing a full TEE with the pacing stethoscope in place was problematic or impossible in half of the patients because of considerable friction between the electrodes of the stethoscope and the shaft of the TEE probe.

Transesophageal atrial pacing at a rate of 100 beats/min increased arterial blood pressure and cardiac index and decreased systemic vascular resistance (table 1), suggesting that moderate increase in heart rate improves hemodynamic performance in the presence of preexisting mitral valve disease. This effect is in contrast to the report by Kamp *et al.*⁵ in which much more rapid pacing (160 beats/min) was used to induce ventricular ischemia, which then resulted in worsening of MR because of changes in left ventricular geometry.

Although Helmcke *et al.*¹⁵ reported that the mitral regurgitant jet area, as measured with Doppler color flow mapping, is useful for the accurate estimation of the severity of MR, this view is controversial. If the mitral regurgitant jet is eccentric, such as in the current case, it is difficult to estimate the severity of MR accurately by this method. Bargiggia *et al.*⁷ and Grossmann *et al.*⁸ reported that during such circumstances, the proximal

isovelocity surface area of the flow convergence region proximal to the regurgitant orifice is a better index of the severity of MR than is the mitral regurgitant jet area. In addition, Bargiggia *et al.*⁷ studied the relationship between the maximal instantaneous regurgitant flow rate and the angiographic grade of MR and found that the discriminant value between moderate MR and moderate to severe MR is 130 ml/s. Although the width and the length of the eccentric regurgitant jet did not change in the current case, the radius of the proximal isovelocity surface area increased from 0.8 to 1.2 cm and the maximal instantaneous regurgitant flow rate increased from 129 ml/s to 289 ml/s after the interruption of pacing (fig. 2). These findings suggest that the severity of MR was reduced by pacing.

Klein *et al.*^{9,10} reported that the pulmonary venous flow pattern is influenced by the severity of MR; that is, 26 of 28 patients (93%) with 4+ MR had reversal of systolic flow, 11 of 12 patients (92%) with 3+ MR had blunted systolic forward flow, and 5 of 10 patients (50%) with 2+ MR had normal biphasic pulmonary venous flow. In the current case, the pulmonary venous flow pattern changed from a normal biphasic pattern to a blunted pattern after the interruption of pacing (fig. 3), suggesting that the severity of MR was 3+ in the absence of pacing, and this was improved by pacing.

In summary, transesophageal atrial pacing using a bipolar lead attached to the TEE probe was useful and effective for the treatment of sinus bradycardia and hypotension in patients with MR because positioning of the pacing lead was easy and rapid, and stable atrial capture could be obtained during manipulation of the TEE probe.

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Cannulation of the Cervical Epidural Venous Plexus: A Rare Complication of Retrograde Internal Jugular Vein Catheterization

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PERCUTANEOUS retrograde cannulation of the internal jugular vein (IJV) is a widely used technique for cerebral venous sampling in intensive care treatment of head-injury patients. Although a multitude of complications

associated with IJV catheterization have been described, epidural venous plexus cannulation with this technique has not been reported.

We report a case of unintentional cannulation of the anterior venous plexus of the cervical epidural space during retrograde catheterization of the right IJV in a polytrauma patient.

Case Report

A 17-yr-old boy was admitted to the emergency room of the San Raffaele Hospital after a motor vehicle accident. The patient was comatose and underwent computed tomography of the head and the thorax and was found to have cerebral and pulmonary contusions.

At admission to the neurointensive care unit, he had mild anisocoria, and pupillary reflexes were bilaterally present. The Glasgow Coma Score was 6, and he was sedated and mechanically ventilated. A central venous catheter was placed in the right subclavian vein, and intracranial pressure was monitored by intraventricular catheter.

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Key words: Cerebral venous sampling; head injury; vertebral plexus.