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CLINICAL REPORT

Role of intraoperative transesophageal echocardiography in detecting masked mitral regurgitation during left atrial myxoma surgery

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Abstract Myxomas are the most common type of cardiac tumor. Mobile or large left atrial (LA) myxomas frequently cause functional mitral stenosis, and can lead to mitral regurgitation (MR). Difficulties have been associated with detecting masked MR jets and evaluating the severity of MR during LA myxoma surgery due to the presence of a prolapsing tumor and changes in blood flow. We herein presented a case of LA myxoma with significant MR diagnosed on intraoperative transesophageal echocardiography (TEE) prior to cardiopulmonary bypass. Repeated careful observations on TEE led to a confident diagnosis of MR and the selection of an additional appropriate procedure. This case study highlighted the importance of intraoperative TEE in supporting clinical decision-making for optimal mitral valve procedures during LA myxoma surgery.

Keywords Intraoperative transesophageal echocardiography · Myxoma · Mitral regurgitation

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Introduction

Myxomas are the most common type of cardiac tumor and can arise in any cardiac chamber, but are typically in the left atrium (LA). LA myxomas frequently cause functional mitral stenosis (MS), but rarely lead to mitral regurgitation (MR) [1]. However, recent studies identified the mechanism (the "wrecking ball" effect) by which the motion of a tumor hampers valve closure or damages the mitral valve (MV) [1–3]. Although many cases have been reported in which MR was diagnosed following tumor resection [4–7], MR and its severity were only identified prior to surgery in a few cases [8, 9]. We herein presented a case of LA myxoma with significant MR diagnosed intraoperatively before tumor resection using intraoperative transesophageal echocardiography (TEE). We outlined why MR could not be detected easily in myxoma surgery and the conditions under which masked MR jets were observed even in the presence of tumors.

Case report

A 50-year-old man, weight 65 kg and height 173 cm, was scheduled to undergo resection for LA myxoma. Preoperative transthoracic echocardiography (TTE) (Fig. 1, movie clip 1) revealed a large (6 × 4 × 5 cm) LA myxoma attached to the interatrial septum, functional MS [the mean transmitral pressure gradient (MPG) was 9.1 mmHg] without significant MR, and moderate tricuspid regurgitation (TR). Following the induction of general anesthesia with propofol, fentanyl, and rocuronium, the trachea was intubated with an endotracheal tube (internal diameter 8.0 mm). A multiplane TEE probe (Omni III 21378A; Philips Medical Systems, Andover, MA) was then inserted

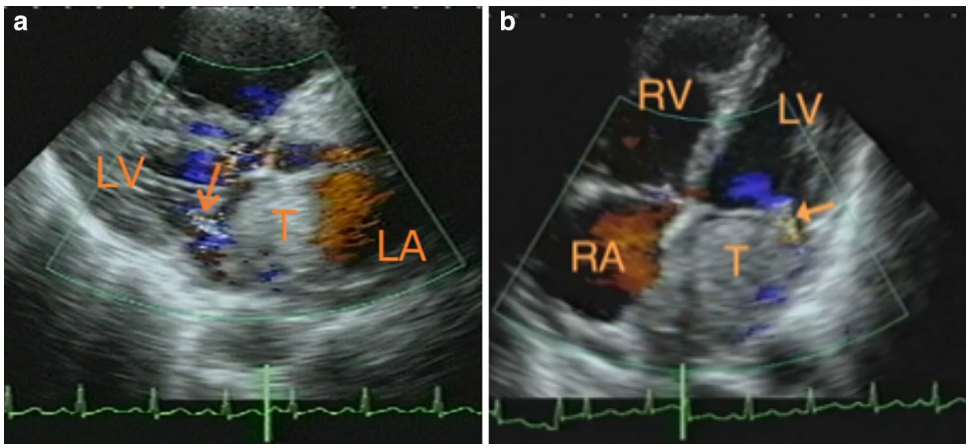

Fig. 1 Preoperative transthoracic echocardiography images of the parasternal long-axis view (**a**) and apical 4-chamber view (**b**) with color-flow Doppler showing large left atrial myxoma occupying the left atrium. Electrocardiogram showing that this image was captured at the end of systole, during which the myxoma almost completely occluded the mitral valve orifice. **a** A color jet, suspected to be the mitral regurgitation jet, was observed in the left atrium, whereas a clinically significant mitral regurgitation jet was not detected. **b** Color-flow Doppler imaging showing minor flow convergence (*arrow*) inside the left ventricle, which may be a sign of mitral regurgitation; however, a significant mitral regurgitation jet was not detected in the left atrium. *LA* left atrium, *LV* left ventricle, *T* tumor, *RV* right ventricle, *RA* right atrium

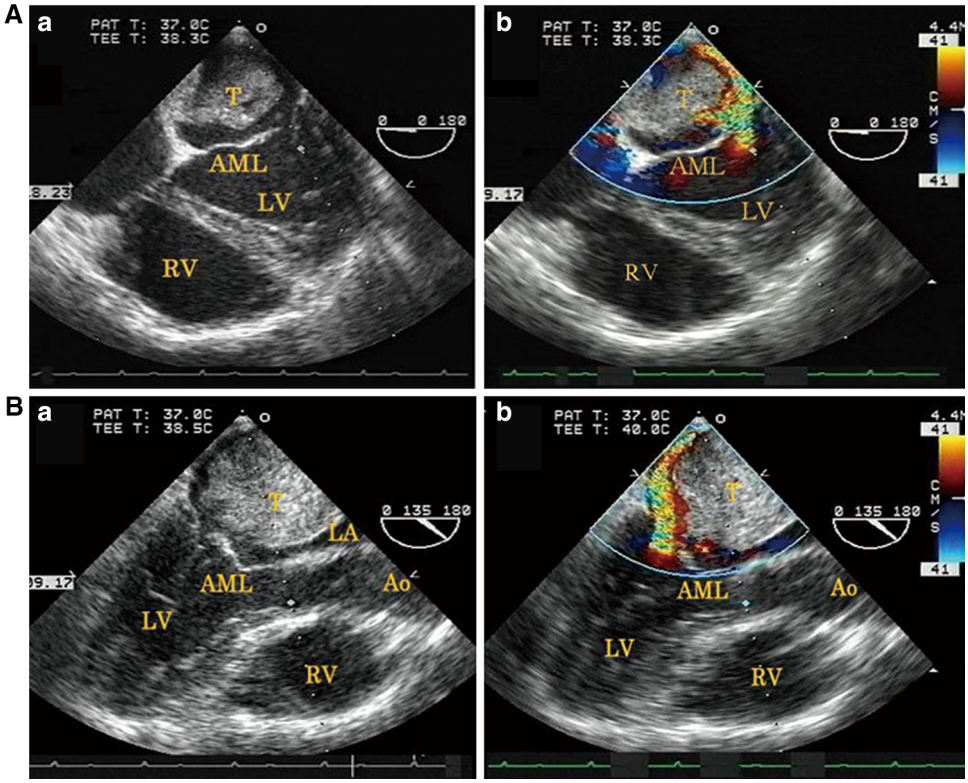

Fig. 2 A two-dimensional image (**a**) showing the prolapsed middle segment of the anterior mitral valve leaflet (A2) and color-flow Doppler imaging (**b**) showing an eccentric mitral regurgitation jet directed away from the anterior mitral valve leaflet in a posterolateral direction. **a** Transesophageal echocardiography (TEE) image of the mid-esophageal 4-chamber view [two-dimensional image (*a*) and color-flow Doppler image (*b*)]. **b** TEE image of the mid-esophageal long-axis view at 135° [two-dimensional image (*a*) and color-flow Doppler image (*b*)]. *LV* left ventricle, *RV* right ventricle, *T* tumor, *AML* anterior mitral valve leaflet, *Ao* ascending aorta, *LA* left atrium

through the esophagus, and routine preoperative TEE confirmed LA myxoma with severe MS (MPG was 18.7 mmHg) (Movie clip 2) and moderate TR due to tricuspid annular dilatation. We could not confirm any significant MR jets in the first routine TEE evaluation. After anesthetization, a decrease in the cardiac preload after reduced venous return caused both a deterioration in MS and hypotension [systolic blood pressure (SBP) < 80 mmHg, with central venous pressure (CVP) of 4 mmHg], and these were recovered by a 1000 ml isotonic crystalloid

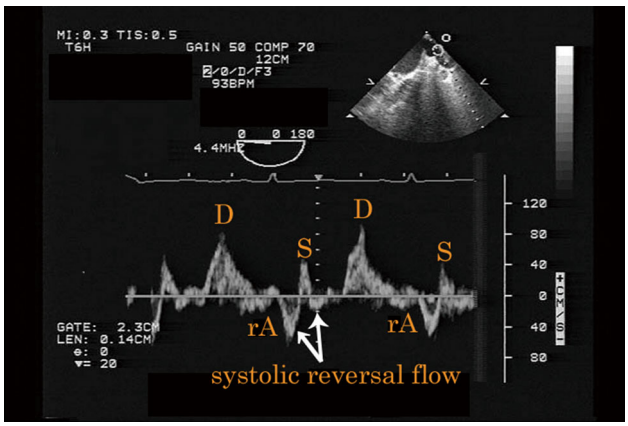

Fig. 3 Pattern of pulmonary venous flow in the left upper pulmonary vein on pulsed-wave Doppler imaging during sinus rhythm. The *arrows* indicate systolic (early systolic and late systolic) flow reversal. *S* systolic wave (S wave), *D* diastolic wave (D wave), *rA* atrial reversal

infusion (SBP of 100 mmHg, and CVP reached 6 mmHg). Surgery commenced one hour later, and a sequential intraoperative TEE assessment revealed an eccentric MR jet with prolapse of the middle segment of the anterior mitral leaflet (A2) (Fig. 2, movie clip 3), which had not been evident on preoperative TTE or the first routine preoperative TEE. The MR jet that reached the LA posterior wall divided into two different directions and was considered to be moderate (vena contracta was 6 mm). Pulmonary venous flow (PVF) on pulsed-wave Doppler indicated severe MR (Fig. 3). Cardiopulmonary bypass (CPB) was established by bicaval cannulation, and cardioplegic arrest was induced by antegrade cold blood cardioplegia. The tumor was then excised. Direct inspection of the MV revealed prolapse of the A2 segment, which was attributed to tumor-induced stretching of the MV without annular dilatation. Although valve repair should be performed whenever feasible, the MV was replaced with a 29 mm bileaflet mechanical valve in our case, because only a part of the prolapsing segment was irreparably thickened. A pathological examination of the excised MV showed no myxomatous degeneration. Tricuspid annuloplasty was performed to repair the dilated annulus. The patient was weaned from CPB and a post-bypass TEE examination revealed no pathological MR. He had an uneventful recovery.

Discussion

A large LA mass can physically contact and strike the MV and subvalvular apparatus with every heartbeat. This phenomenon may thicken and inflame the MV, which may lead to MV damage. Two types of MV damage are generally caused by prolapsing LA tumors: annular dilatation and valve prolapse. In our case, MR was caused by anterior leaflet prolapse without annular dilatation. The mechanism responsible for MV damage can determine the degree of obstruction of the MV orifice by the tumor. Myxomas with annular dilatation may almost completely cover the MV orifice throughout the cardiac cycle and easily mask the MR jets because of incarceration of the tumor to the dilated annulus. In such a case, MR cannot be detected prior to surgery, but may be identified after tumor resection [6, 7]. On the other hand, myxomas with leaflet prolapse may partially cover the MV orifice during diastole only and partially mask the MR jets because of the prolapsing leaflet into the LA during systole. Therefore, this masking effect may be more frequently observed in myxomas with annular dilatation than in myxomas with leaflet prolapse.

Many studies demonstrated that preoperative TTE or TEE failed to detect MR in the presence of a myxoma, and intra/post-operative TEE revealed significant MR following myxoma resection [4–7]. In these cases, CPB was reinstituted and repeat cardioplegic arrest was induced to correct the MV. On the other hand, the severity of MR was only correctly diagnosed before myxoma resection in a few cases [8, 9].

The following factors can explain the difficulties associated with detecting a masked MR jet and the reasons that finally enabled the detection of MR by TEE prior to myxoma resection. First, since the tumor diverts the jet, which causes turbulent flow around the tumor, TTE cannot cut through an adequate flow plane. Therefore, multiplanar TEE has an advantage over TTE because it allows arbitrarily oriented planes. Second, MR in our case was caused by leaflet prolapse without annular dilatation. Thus, the masking effect of the tumor on the MR jets may have been reduced. Under sufficient loading conditions, the distance between the tumor and MV was sufficiently wide to evaluate the prolapsing leaflet into the LA, and preoperatively detect masked MR. A sufficient distance between the tumor and MV during systole and a clearly visible MR jet are needed to evaluate the severity of and mechanism responsible for MR. Therefore, we could decide an adequate indication of MV surgery and guide the surgical procedure. Furthermore, the patient received volume loading for the recovery of hypotension and deterioration in MS after being anesthetized, which may have made the distance between the MV and myxoma wider and affected the ability of the myxoma to "float" freely in the LA. This volume loading may have strongly influenced the visualization of masked MR. Therefore, we could clearly identify the masked MR jet using intraoperative TEE. Additionally, an increased after load during the second TEE examination, because surgery had already started, may also have

affected the MR status and deteriorated the MR jets. Another reason why MR was not detected in preoperative TTE may have been due to differences in the position of the patient (supine in OR, left lateral decubitus in the echo lab). The MR jet could not be detected because the space between the tumor and LA posterior wall at the mid-portion of the MV was narrower when the patient was lying in the left lateral decubitus position during preoperative TTE.

Although PVF may help diagnose the severity of MR, the evaluation of PVF under a prolapsing LA tumor needs careful attention. The systolic backward movement of the tumor through the MV has been reported to affect the PVF pattern, with early systolic reversal flow being observed in PVF [10]. Late systolic reversal flow has also been observed in significant MR. PVF in our case indicated both early and late systolic reversal flow. Therefore, PVF should be examined in more detail in spite of the limitations that occur under a prolapsing LA tumor.

In conclusion, this case showed that intraoperative TEE can play an important role in detecting masked MR and support decision-making for appropriate MV procedures. Many factors in myxoma surgery can lead to an underestimation or overlooking of the MR jets, and influence the conversion of masked MR to visible MR, especially under different loading conditions. To avoid ineffective therapy and a second session of CPB during prolapsing myxoma surgery, anesthesiologists and the surgical team should recognize the limitations of preoperative echocardiographic studies in the evaluation of MR. TEE should be used repeatedly to evaluate the potential presence of MV dysfunction before and after tumor resection.

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