Exaggerated Posterior Aortic Wall Excursion
A New Echocardiographic Feature of Atrial Septal Defect with Left to Right Shunt?

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SUMMARY
In 32 adult patients with a secundum type atrial septal defect (ASD) and normal pulmonary vascular resistance, the posterior aortic wall excursion (AoE) was measured using M-mode echocardiography, before, 16.2±4.5 days after, and 2.4±1.1 years after operative repair of the ASD. This parameter was also measured in 50 control subjects. The AoE index (AoE corrected for body surface area) in patients with ASD was significantly greater than in disease-free subjects (0.81 vs 0.59 cm, p<0.01). When the AoE index was plotted against the pulmonary to systemic blood flow ratio (Qp/Qs) obtained by the Fick method, a single linear relationship was evident (r=0.65, p<0.01). The index normalized within 1 month after the operation; left ventricular dimension index became normal only 1 year after the operation. The right ventricular dimension index remained enhanced even 1 year after the operation. We suggest that exaggerated AoE might be another echocardiographic feature of ASD with normal pulmonary vascular resistance.

Additional Indexing Words:
M-mode echocardiography Surgical operation Qp/Qs

ECHOCARDIOGRAPHY is the most useful noninvasive method for evaluation of atrial septal defect (ASD).1-5 Paradoxical septal motion and an increased right ventricular diastolic dimension (RVD) are two representative characteristics of the clinical disorders with a right ventricular
volume overload, including ASD. In addition, the posterior aortic wall excursion (AoE) seems to be exaggerated in patients with ASD and a significant left to right shunt. We attempted to determine whether AoE is greater in patients with ASD than in disease-free subjects and whether the index correlates with the ratio of pulmonary to systemic flow (Qp/Qs) in patients with ASD. We also compared the value of the AoE index before, soon, and late after operative closure of ASD, since several studies have shown that other echocardiographic parameters of ASD such as right ventricular dilatation or abnormal ventricular septal motion frequently persist after operative repair of the ASD.\textsuperscript{11,41–7}

**Materials and Methods**

Echocardiographic studies were done in 32 Japanese patients with secundum type ASD, before surgical closure of the defect, and during both early (16.2±4.5 days) and late (2.4±1.1 years) postoperative phases. The 17 male and 15 female subjects ranged in age from 15 to 59 years, the average being 33.9±11.9 years. Preoperatively, all patients underwent right heart catheterization. The magnitude of shunting from left to right was determined by the Fick method from intracardiac oxygen saturation levels and was expressed as the Qp/Qs. In all patients there was a normal pulmonary vascular resistance and no other congenital cardiac abnormalities.

For a control study, 50 disease-free adults were also examined echocardiographically. These subjects included 24 men and 26 women who ranged in age from 22 to 56 years, the average being 35.4±8.2 years. Echocardiographic examination was performed using a Toshiba SSH-11A sonolayergraph phased array sector scanner with a 78° scanning angle, equipped with a 32-element, 2.4 MHz transducer. The examinations were done with the patients rotated 30° into a left lateral decubitus position with the transducer along the left sternal border. M-mode echocardiograms were sampled and recorded on dry-silver paper with a Honeywell strip chart recorder.

The posterior aortic wall excursion (AoE) was measured by subtracting the end-diastolic dimension from the end-systolic dimension of the left atrium. The left atrial dimension was measured from the leading edge of the posterior aortic wall echo at the maximal anterior motion of the aortic wall to that of posterior left atrial wall, when both these structures and the aortic valve were clearly identified (Fig. 1). The RVD was measured from the leading edge of the endocardial surface of the RV anterior wall to that of the RV surface of the interventricular septum, and the left ventricular diastolic dimension (LVD) was measured from the leading edge of the LV surface of the interventricular
Fig. 1. M-mode echocardiogram of a normal control subject (extreme left) and representative series of M-mode echocardiograms of a 38 year old woman with ASD who underwent corrective surgery. The exaggerated posterior aortic excursion in the preoperative state decreased soon after operation. preop = preoperative; postop = postoperative; RVOFT = right ventricular outflow tract; Ao = aorta; AoE = aortic wall excursion; LA = left atrium.

Results

Echocardiographic data from patients with ASD and normal subjects are shown in Figs. 2 and 4. The preoperative AoE index in patients with ASD was $0.81 \pm 0.15$ cm (mean $\pm$ SD), and was significantly greater than that ($0.59 \pm 0.14$ cm) in normal subjects ($p < 0.01$) (Fig. 2). When the AoE index was plotted against $Q_p/Q_s$, a correlation was evident ($y = 0.08x + 0.54$, $r = 0.65$, $p < 0.01$) (Fig. 3). This index normalized soon after surgery and there was no statistical difference between early ($0.51 \pm 0.14$ cm) and late ($0.47 \pm 0.10$ cm) postoperative states.

The preoperative RVD index in patients with ASD was $2.27 \pm 0.47$ cm, which was greater than that ($0.99 \pm 0.27$ cm) in normal adults ($p < 0.01$) (Fig. 4). When the RVD index was plotted against the $Q_p/Q_s$, there was no
Fig. 2. The aortic excursion index (mean value and standard deviation) of normal control (extreme left), and those of subjects with ASD before, soon and late after operation. AoE = aortic wall excursion; p = p value; n.s. = not significant; preop = preoperative; postop = postoperative.

Fig. 3. The aortic wall excursion index is plotted against Qp/Qs. A linear correlation was noted. The correlation coefficient was 0.65 (p < 0.01).

Fig. 4. The right ventricular dimension (RVD) index and left ventricular dimension (LVD) index (mean value and standard deviation) of normal control and those of subjects with ASD before, soon and late after operation. Abbreviations and shadings are as in Fig. 2.
correlation. The RVD index prominently decreased (1.71±0.50 cm) within the first month after operation, and decreased further (1.48±0.37 cm) over 1 year after the operation. There was a significant difference in this index between early and late after operation (p<0.01).

The preoperative LVD index was 2.4±0.26 cm in patients with ASD, which was significantly smaller than that (2.9±0.31 cm) of normal subjects (Fig. 4). The LVD index did not normalize until 1 year after the operation (2.8±0.26 cm). The late postoperative LVD index was significantly greater than both preoperative (p<0.01) and early postoperative (2.4±0.36 cm) LVD indices (p<0.01).

**Discussion**

This study indicates that the exaggerated posterior AoE is another echocardiographic feature of ASD, that the AoE index is correlated with the Qp/Qs and that this motion normalizes soon after operative repair of the defect. The posterior AoE was previously proposed as a valuable index of the LA volume curve, and to be an indirect index of LV volume change only if sinus rhythm was present and mitral valve regurgitation or ASD was absent. In considering the LA volume change, the AoE in ASD with normal pulmonary vascular resistance must be magnified because the LA volume change during diastole is a summation of the diastolic filling flow from the LA into both the LV and the RV, due to the left to right shunt at the atrial septum. However, when the interatrial septal defect is closed surgically, the LA is unable to empty the volume into the RV through the defect; rather it only empties into the smaller-than-normal LV. As a result, the AoE index (which is correlated with the LV volume change) becomes smaller immediately after surgical repair of the ASD (Fig. 2). Time is required for the dilated RV to contract, and for the subnormal LV to dilate to normal size after the surgery (Figs. 3 and 4). This may explain the differences in the early postoperative findings between the AoE index and dimension indices of both ventricles. This acute postoperative change is also different from the paradoxical motion of the interventricular septum which sometimes continues postoperatively.

Since substantial patient to patient variability limits the predictive value of this index regarding the magnitude of left to right shunt, it should not be used to yield major inferences. However, we propose that an exaggerated posterior AoE is an additional echocardiographic feature of ASD with normal pulmonary vascular resistance. Though the coefficient is low, this index is correlated with Qp/Qs and it normalizes soon after surgery, which differs...
from changes in RVD, LVD or paradoxical interventricular septal motion.

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REFERENCES