Echocardiographic diagnosis of left atrial myxoma

Usefulness of suprasternal approach

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Three cases of left atrial myxoma were studied by echocardiography. In one case the atrial tumour was prolapsing through the mitral orifice into the left ventricular cavity; in the other two cases it was not. The angiocardigraphic and operative findings correlated well with those from echocardiography. A systematic echocardiographic study is important; the suprasternal approach is useful in the echocardiographic exploration of the left atrium, especially for nonprolapsing tumours.

The value of echocardiography as a screening test in the diagnosis of atrial tumours has been well established (Wolfe, Popp, and Feigenbaum, 1969; Popp and Harrison, 1969; Kostis and Moghadam, 1970; Finegan and Harrison, 1970; Spencer, Peter, and Orgain, 1971; Waxler, Kawai, and Kasparian, 1972; Nasser *et al.*, 1972; Johnson *et al.*, 1973; Kleid *et al.*, 1973; Martinez, Giles, and Burch, 1974; Kerber, Kelly, and Gutenkauf, 1974). The need for a systematic approach in the echographic study of the mitral valve and the left atrium, for detection of abnormal clouds of echoes, has been emphasized (Nasser *et al.*, 1972; Johnson *et al.*, 1973; Martinez *et al.*, 1974). Our experience with the echographic exploration of the left atrium using the suprasternal approach in three cases of left atrial myxoma is presented as a means of improving the diagnostic accuracy of the technique.

Methods

We performed echocardiography using a Unirad Ultrasonoscope and an unfocused transducer, with a piezoelectric crystal 9.5 mm in diameter, with a primary resonant frequency of 2.25 MHz. The echocardiograms were recorded either on Polaroid film directly from the conventional oscilloscope, or on a strip chart record, with the Honeywell model 1856 fibreoptic system.

In the routine technique, the patients were

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studied in the supine position, with the transducer on the anterior chest wall just to the left of the sternum in the third or fourth intercostal space. The ultrasound beam was carefully manipulated until the characteristic pattern of motion of the anterior mitral valve leaflet was identified. The beam was then directed superiorly and medially until the parallel echoes of the aortic root were encountered. From this position the aortic cusps were identified by minor variations in transducer angulation, and recordings were initiated while the ultrasound beam was slowly directed inferolaterally along the main axis of the left ventricle to a point immediately distal to the mitral valve leaflets.

In the suprasternal approach, the transducer was positioned in the suprasternal notch and was directed caudad. The ultrasound beam passed through the aortic arch, right pulmonary artery, and left atrium (Fig. 1).

Case reports

Case 1

A 30-year-old white woman was referred to Hahneman Hospital with a 5-month history of progressive dyspnoea on exertion, associated with irregular palpitation and heavy substernal pain radiating to the left arm on exertion. However, on other occasions she was completely free from symptoms. Pertinent physical findings were a blood pressure of 120/70 mmHg (160/9.3 kPa), a regular

FIG. 1 *Suprasternal approach: the transducer is positioned in the suprasternal notch and directed caudad. The ultrasound beam passes through the aortic arch, right pulmonary artery, and left atrium. The suprasternal echocardiogram displayed here is the postoperative study of Case 2. Ao: aortic arch; LA: left atrium; RPA: right pulmonary artery.*

pulse of 80/min, no jugular venous distension, and clear lung fields. The heart was not enlarged; the first heart sound was loud and the second heart sound was physiologically split. An early diastolic sound, with a grade 2–3/6 diastolic murmur, was heard at the apex. There was no peripheral oedema.

The electrocardiogram was within normal limits. A chest x-ray film showed normal heart size and configuration, but increased vascular markings in both lung fields.

The echocardiogram (Fig. 2A) showed a cloud of echoes under the anterior mitral leaflet during diastole and a reduced diastolic slope of the mitral leaflet. The study in Fig. 2A was performed with the routine technique, with the transducer positioned in the fourth intercostal space along the left sternal border. The ultrasound beam was directed posteriorly until the anterior mitral leaflet was identified. With the transducer directed inferiorly from the suprasternal notch, the echocardiogram (Fig. 2B) shows the abnormal echo cluster in the left atrium only during systole. On angiocardiography, the size of the left atrium was at the upper limit of normal, but there was a large smooth filling defect in the left atrium near the mitral valve, moving back

and forth through the mitral valve into the left ventricle. A mean diastolic gradient of 8 mmHg (1.1 kPa) was recorded across the mitral valve.

A myxomatous tumour was found in the left atrium at operation and was removed.

Case 2

A 37-year-old black woman was referred to Jackson Memorial Hospital in Miami, with a four-week history of atrial fibrillation, congestive heart failure, and persistent cough. She was not improving clinically despite treatment with digitalis and diuretics. During her stay in hospital, varying auscultatory findings were noted, including a pansystolic murmur, a mitral 'honk', and a diastolic rumble.

The electrocardiogram showed atrial fibrillation and nonspecific ST-T wave abnormalities. A chest x-ray film showed considerable pulmonary venous congestion and a mitral configuration of the heart. The haemoglobin was 10.8 g/dl and haematocrit 32.5 per cent.

The echocardiogram did not show a cloud of echoes under the distal portion of the anterior

FIG. 2 Echocardiogram of Case 1. (A) With the ultrasound beam directed posteriorly from the conventional anterior position, an abnormal cluster of echoes is produced by the myxoma behind the anterior mitral leaflet as the tumour prolapses into the left ventricle during diastole. The velocity of mitral closure during diastole is much reduced, as in mitral stenosis. (B) Echocardiogram obtained using the suprasternal approach shows the prolapsing motion of the pedunculated myxoma, which appears as a dense cluster of echoes in the left atrium during ventricular systole. Simultaneously recorded phonocardiogram and electrocardiogram are displayed below.

mitral leaflet during diastole, but abnormal echoes did fill the entire left atrium behind the aortic root when the sound beam was directed more medially and superiorly. These abnormal echoes were clearly seen to be within the left atrial cavity when the suprasternal approach was used. They were identifiable during both ventricular systole and diastole, suggesting a failure of the tumour to enter the left ventricle.

Cardiac catheterization showed a mean diastolic gradient of 24 mmHg (3.2 kPa) across the mitral valve. The pulmonary vascular resistance was raised, and the pulmonary artery wedge pressure tracing showed a prominent *c* wave and rapid *y* descent. During angiocardiography, a large irregular mass was seen to occupy most of the cavity of the left atrium; the tumour mass appeared to move towards the mitral orifice in diastole, obliterating the orifice but not entering the left ventricular

cavity; it moved back into the left atrium during systole.

These findings were confirmed at operation and the tumour was excised.

After surgical removal of the tumour repeat echocardiogram using the suprasternal approach showed that the left atrial cavity was free from abnormal echoes (Fig. 1). No abnormal echoes were detected within the left atrium and motion of the anterior mitral leaflet was normal by the conventional anterior approach.

Case 3

A 60-year-old white woman was referred to Jackson Memorial Hospital, with a history of decreasing exercise tolerance, and episodes of chest tightness and dyspnoea unrelated to physical activity, all developing over a period of 18 months.

There was also history of paroxysmal nocturnal dyspnoea and lightheadedness. Pertinent findings were a blood pressure of 150/80 mmHg (20.0/10.6 kPa) and a regular pulse of 84/min. There was no jugular venous distension. The chest was clear, and heart was not enlarged; the first heart sound was increased in intensity, and the second heart sound was physiologically split. A grade 2/6 early systolic murmur was heard at the left lower sternal border and the apex.

The electrocardiogram showed regular sinus rhythm and nonspecific ST-T wave abnormalities. The chest x-ray film was unremarkable.

An echocardiogram (Fig. 3A) showed that the motion of the anterior mitral leaflet was normal. No cloud of echoes was seen under the anterior mitral leaflet which moved normally during diastole. Multiple abnormal echoes were inconstantly identified behind the aortic root within the left atrium. Many of these were of extremely high intensity, suggesting calcification within a solid lesion. This seemed to move several millimetres within the left atrium but did not prolapse into the left ventricle. This finding was confirmed by echocardiograms from the suprasternal approach (Fig. 3B), with the cluster of echoes being clearly shown within the left atrium throughout the cardiac cycle. The echocardiographic study suggested a mobile atrial tumour mass, which failed to enter the left ventricle when the patient was in the supine position.

During angiocardiography, a 3 × 5 cm left atrial

mass was seen. It occupied 70 to 80 per cent of the left atrial cavity and bounced up and down in the left atrium. It appeared to hit the atrial wall during ventricular systole and return toward the mitral orifice during diastole, but did not pass through the mitral valve orifice. The periphery of the tumour mass, easily identified during fluoroscopy, was seen to be calcified. A 5 mmHg (0.7 kPa) mean diastolic gradient was found across the mitral valve.

The findings were confirmed during operation, and the tumour was excised.

Discussion

As recently as two decades ago, atrial myxoma, the most common intracavitary tumour of the heart, was diagnosed only at necropsy or, at best, during thoracotomy. After the first successful surgical removal of an atrial myxoma in 1954 (Crafoord, 1955), the need for early preoperative diagnosis of this uncommon disorder was emphasized.

Several clinical investigators agree that atrial myxomata usually present clinically in one or more of three ways: by embolization, and/or by obstruction to blood flow, and/or by constitutional manifestations (Goodwin, 1963). The symptoms and signs, though useful in alerting the doctor to the possibility of atrial myxoma, are not diagnostic of this clinical entity which often simulates other conditions. Electrocardiography, phonocardi-

FIG. 3 Echocardiogram of Case 3. (A) Conventional echocardiogram shows normal unobstructed motion of the anterior mitral valve leaflet during diastole. Echoes originating from the mobile but nonprolapsing myxoma within the left atrium are also present but disappear as the ultrasonic beam is directed inferiorly into the left ventricle. (B) Suprasternal approach: a cluster of echoes remaining throughout the cardiac cycle within the left atrium originates from the myxoma. Decreasing intensity settings from left to right indicate that these abnormal echoes are not technical artefacts. AMV: anterior mitral leaflet; Ao: aortic arch; CW: chest wall; ECG: electrocardiogram; LA: left atrium; MYX: myxoma; Rt PA: right pulmonary artery; Sep: interventricular septum.

graphy, and apex cardiography may provide data suggestive of atrial tumour (Ghahramani *et al.*, 1972; Nasser *et al.*, 1972). Angiocardiography was first used in the clinical diagnosis of this disorder in 1951 (Goldberg *et al.*, 1952), and is now considered the definitive preoperative investigation, though false-positive and false-negative results occur. As a screening procedure, echocardiography is preferable to angiocardiography, which is an invasive procedure, with the risk of dislodgement of portions of left atrial myxoma, especially when the transseptal technique is used, and is also expensive and inconvenient.

The use of reflected ultrasound in the diagnosis of a left atrial tumour was first described in Germany in 1959 (Effert and Domanig). The first report in America appeared in 1968 (Schattenberg) and dealt with the value of echocardiography in differentiating between mitral stenosis and left atrial tumour. Since then several reports of successful preoperative diagnosis of left and right atrial tumours by echocardiography have appeared (Wolfe *et al.*, 1969; Popp and Harrison, 1969; Kostis and Moghadam, 1970; Finegan and Harrison, 1970; Spencer *et al.*, 1971; Waxler *et al.*, 1972; Nasser *et al.*, 1972; Johnson *et al.*, 1973; Kleid *et al.*, 1973; Martinez *et al.*, 1974; Kerber *et al.*, 1974). This technique, which is simple, noninvasive, and easily reproducible, has become popular as a screening test for atrial tumours. A mass or cloud of echoes under the anterior mitral valve leaflet during ventricular diastole is now considered diagnostic of left atrial tumour, and similarly a mass of echoes under the tricuspid leaflet is diagnostic of right atrial tumour. The diastolic slope of the anterior mitral leaflet is reduced, as in mitral stenosis, because the valve is held open by the tumour. These echocardiographic signs suggest a pedunculated atrial tumour, prolapsing through the mitral orifice into the left ventricular cavity during diastole and returning to the left atrium during ventricular systole (Nasser *et al.*, 1972; Johnson *et al.*, 1973).

Most atrial myxomata are pedunculated and traverse the atrioventricular orifice during diastole (Greenwood, 1968). However, the routine echocardiographic technique for the study of the mitral valve, placing the transducer in the fourth intercostal space along the left sternal border with the beam directed posteriorly, may fail to detect those atrial tumours which do not traverse the atrioventricular orifice. In such cases, exploration of the left atrium by ultrasound may reveal a mass of echoes within the left atrial cavity (Nasser *et al.*, 1972). Johnson *et al.* (1973) have stressed the importance of examining the mitral valve from many different angles. They reported the echocardiographic features of a left atrial myxoma which was

attached to the superior left atrial wall instead of having the usual attachment to the interatrial septum; the diagnostic mass of echoes was recorded when the ultrasound beam was directed more laterally and inferiorly but was not seen when the beam was directed in the usual manner through the anterior mitral leaflet. Martinez *et al.* (1974) suggested that to arrive at a reliable echocardiographic diagnosis echoes must be obtained in at least three directions: (1) through both leaflets of the mitral valve and left ventricle; (2) through the aorta and left atrium; and (3) in an intermediate direction, through the anterior leaflet of the mitral valve and left atrium; the authors observed that this echo was difficult to record unless the left atrium was enlarged.

In this report, we describe three cases of atrial myxoma in which the echocardiogram was particularly helpful as a screening test. The suprasternal approach was used in all three cases, and in two of these was crucial. The first case is a classic example of a pedunculated left atrial tumour prolapsing through the mitral orifice into the left ventricular cavity during diastole and returning to the left atrium during systole. The characteristic cloud of echoes under the anterior mitral leaflet was readily seen during the study of the mitral valve using the standard technique. The second and third cases are examples of left atrial tumours that did not prolapse through the mitral orifice into the left ventricular cavity in diastole. A false-negative echocardiographic study could have been obtained if the mitral valve alone had been studied. In both cases the echographic exploration of the left atrial cavity was extremely important in detecting the atrial tumours; the approach to the left atrial cavity with the ultrasound beam directed through the aortic root was used in these cases, but we found the suprasternal approach especially useful in exploring the left atrium for these abnormal masses. In this technique, described by Goldberg (1971), the transducer is positioned in the suprasternal notch and the ultrasound beam is directed caudad, traversing the aortic arch, the right pulmonary artery, and the left atrium. In our second and third cases, we readily identified abnormal clouds of echoes originating within the left atrial cavity. Echocardiographic exploration of the left atrial cavity either behind the aortic root using the conventional anterior approach, or by the suprasternal approach, may also be helpful in differentiating atrial tumours from severe calcific mitral stenosis when multiple echoes are often seen in the area of the anterior mitral leaflet in diastole.

References

- Crafoord, C. (1955). Discussion on the technique of mitral commissurotomy. In *Cardiovascular Surgery: Studies in Physiology Diagnosis and Techniques*, pp. 202-203. Ed. by C. R. Lam. W. B. Saunders, Philadelphia.
- Effert, S., and Domanig, E. (1959). The diagnosis of intra-atrial tumours and thrombi by the ultrasonic echo method. *German Medical Monthly*, **4**, 1.
- Finegan, R. E., and Harrison, D. C. (1970). Diagnosis of left atrial myxoma by echocardiography. *New England Journal of Medicine*, **282**, 1022.
- Ghahramani, A. R., Arnold, J. R., Hildner, F. J., Sommer, L. S., and Samet, P. (1972). Left atrial myxoma. Hemodynamic and phonocardiographic features. *American Journal of Medicine*, **52**, 525.
- Goldberg, B. B. (1971). Suprasternal ultrasonography. *Journal of the American Medical Association*, **215**, 245.
- Goldberg, H. P., Glenn, F., Dotter, C. T., and Steinburg, I. (1952). Myxoma of the left atrium: diagnosis made during life with operative and postmortem findings. *Circulation*, **6**, 762.
- Goodwin, J. F. (1963). Diagnosis of left atrial myxoma. *Lancet*, **1**, 464.
- Greenwood, W. F. (1968). Profile of atrial myxoma. *American Journal of Cardiology*, **21**, 367.
- Johnson, M. L., Sieker, H. O., Behar, V. S., and Whalen, R. E. (1973). Echocardiographic diagnosis of a left atrial myxoma found attached to the free left atrial wall. *Journal of Clinical Ultrasound*, **1**, 75.
- Kerber, R. E., Kelly, Jr., D. H., and Gutenkauf, C. H. (1974). Left atrial myxoma. Demonstration by stop-action cardiac ultrasonography. *American Journal of Cardiology*, **34**, 838.
- Kleid, J. J., Klugman, J., Haas, J., and Battock, D. (1973). Familial atrial myxoma. *American Journal of Cardiology*, **32**, 361.
- Kostis, J. B., and Moghadam, A. N. (1970). Echocardiographic diagnosis of left atrial myxoma. *Chest*, **58**, 550.
- Martinez, E. C., Giles, T. D., and Burch, G. E. (1974). Echocardiographic diagnosis of left atrial myxoma. *American Journal of Cardiology*, **33**, 281.
- Nasser, W. K., Davis, R. H., Dillon, J. C., Tavel, M. E., Helmen, C. H., Feigenbaum, H., and Fisch, C. (1972). Atrial myxoma: I. Clinical and pathologic features in nine cases. *American Heart Journal*, **83**, 694. II. Phonocardiographic, echocardiographic, hemodynamic and angiographic features in nine cases. *American Heart Journal*, **83**, 810.
- Popp, R. L., and Harrison, D. C. (1969). Ultrasound for the diagnosis of atrial tumor. *Annals of Internal Medicine*, **71**, 785.
- Schattenberg, T. T. (1968). Echocardiographic diagnosis of left atrial myxoma. *Mayo Clinic Proceedings*, **43**, 620.
- Spencer, W. H., Peter, R. H., and Orgain, E. S. (1971). Detection of a left atrial myxoma by echocardiography. *Archives of Internal Medicine*, **128**, 787.
- Waxler, E. B., Kawai, N., and Kasparian, H. (1972). Right atrial myxoma: echocardiographic, phonocardiographic, and hemodynamic signs. *American Heart Journal*, **83**, 251.
- Wolfe, S. B., Popp, R. L., and Feigenbaum, H. (1969). Diagnosis of atrial tumors by ultrasound. *Circulation*, **39**, 615.

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