NON-INVASIVE SCINTIPHOTOGRAPHIC DIAGNOSIS OF LEFT ATRIAL MYXOMA

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Left atrial myxoma is often unsuspected prior to detection at cardiac surgery for presumed mitral valve dysfunction (*1,2*). Early diagnosis of this potentially life-threatening but curable lesion is essential if complications both at cardiac catheterization and surgery are to be avoided (*3,4*). This report describes the use of radionuclide angiocardiography and ECG-gated scintiphotographic cardiac imaging with the Anger camera (*5*) in the diagnosis of left atrial myxoma.

CASE REPORT

JP (JHH #118 71 58), a 58-year-old white male had been in good health until September 1969 when he experienced the first of three episodes of pulmonary edema and syncope. Auscultory findings suggesting mitral stenosis prompted referral to the Johns Hopkins Hospital for further evaluation. There was no history of rheumatic fever, weight loss, fever, or embolic episodes.

Pertinent physical findings were limited to the chest and heart. The patient had a barrel chest with a marked increase in the anteroposterior diameter. Diffuse rhonchi were present. The cardiac apex could not be palpated. The first heart sound was increased in intensity, and an early diastolic sound and mid-diastolic murmur were intermittently heard in the left lateral position.

The electrocardiogram revealed left atrial abnormality and nonspecific ST and T wave changes. The chest x-ray demonstrated mild left atrial and left ventricular enlargement with emphysematous changes in the lungs. The phonocardiogram revealed S1 to be increased in intensity and duration (0.11 sec). No murmurs or extra sounds could be recorded. Because of the patient's chest configuration an adequate apexcardiogram could not be obtained. Hematocrit, erythrocyte sedimentation rate, and serum protein electrophoresis were all normal. Pulmonary function tests demonstrated a moderately severe obstructive ventilary defect.

Scintiphotographic evaluation revealed the presence of an intracardiac mass (Figs. 1, 2). At cardiac catheterization the right heart pressures were moderately elevated with pulmonary artery = 41/25 (mean = 31 mmHg). A pulmonary arteriogram obtained in the right anterior oblique projection for visualization of the left atrium demonstrated a large globular filling defect which descended partially into the left ventricle during diastole and returned to the left atrium during systole (Fig. 3).

At open heart surgery a 6 × 4.5 × 2-cm polypoid tumor on a stalk attached to the atrial septum was excised (Fig. 4). The histology was typical of myxoma. The postoperative course was uneventful.

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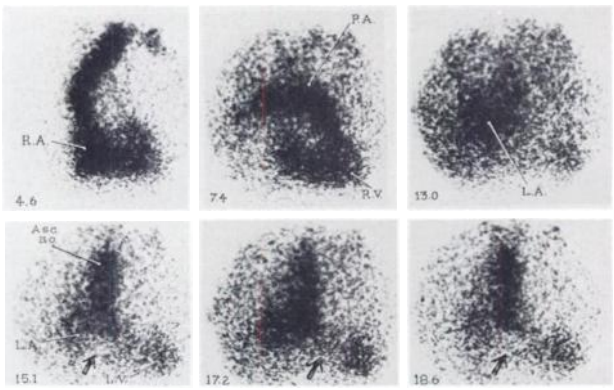

FIG. 1. Selected frames from preoperative radionuclide angiocardiogram. Onset of exposure in seconds after injection for each 0.3-sec frame is indicated. Myxoma filling defect indicated by arrows is seen in region of left atrium, left ventricle, and mitral valve in three lower frames. RA = right atrium, RV = right ventricle, PA = pulmonary artery, LA = left atrium, LV = left ventricle.

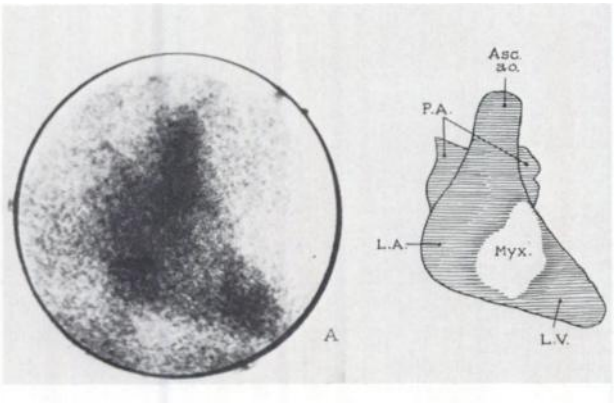

FIG. 2. Preoperative gated end-diastolic cardiac image. In preoperative study large filling defect is present in region of mitral valve and left ventricle. This defect was not present in postoperative study. Myx = left atrial myxoma, LA = left atrium, LV = left ventricle, Asc. Ao = ascending aorta, PA = pulmonary artery.

SCINTIPHOTOGRAPHIC TECHNIQUE

The details and validity of the method have been reported previously (*6–8*). Briefly, the patient was positioned beneath the detector of the Anger scintillation camera which was rotated to view the subject from a 30–40-deg right anterior oblique (RAO) position. The first part of the study was the ungated radionuclide angiocardiogram in which the camera recorded during all parts of each cardiac cycle *(9,10)*. High-activity ^{99m}Tc-labeled serum albumin (20 mCi) was injected as a bolus using Oldendorf's technique (*11*). The initial passage of radioactivity through the right heart, lung, left heart, and aorta was then recorded. Images were obtained for 300 msec at a rate of 2/sec with a 35-mm camera equipped with a motor-driven film transport.

After the radionuclide had equilibrated in the intravascular space, ECG-gated cardiac imaging was performed in which the camera records for only selective parts of each cardiac cycle. In the gated study the camera was controlled by the ECG to collect counts for imaging only during each end-systole and was then reset to collect counts for imaging during each end-diastole. Data from the selected portions of each of 200–400 cardiac cycles were summed to obtain integrated 300,000-count images of the heart and great vessels at end-systole and then again at end-diastole. Gating was achieved using an electronic switch triggered by the R wave of the patient's ECG. The intervals chosen for end-systole and end-diastole were the last 40 msec of the T wave and 60 msec prior to each QRS complex, respectively. The entire procedure required 20–30 min.

RESULTS

During the preoperative ungated radionuclide angiocardiogram, a filling defect in the region of the left atrium and mitral valve could be seen (Fig. 1). This defect was not noted in a comparable postoperative study. The gated end-diastolic image demonstrated a large left ventricular filling defect in and below the region of the mitral valve (Fig. 2). In a postoperative gated study the abnormality noted in end-diastole was no longer present. The defect could not be clearly defined within the atrium in the gated end-systolic image.

There were no false positive studies in a series of five patients with suspected left atrial myxoma and

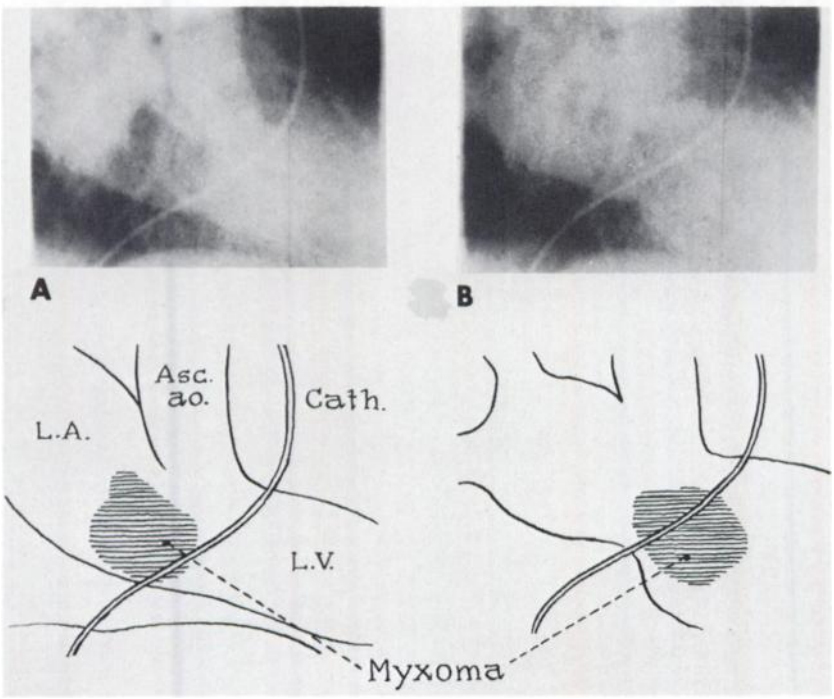

FIG. 3. Two frames from left heart phase of pulmonary arteriogram. Myxoma filling defect can be seen in enlarged left atrium during systole (A). In diastole myxoma moves through mitral valve into left ventricle (B). L.A. = left atrium, L.V. = left ventricle, Asc. Ao = ascending aorta, Cath = catheter positioned in right pulmonary artery for angiography.

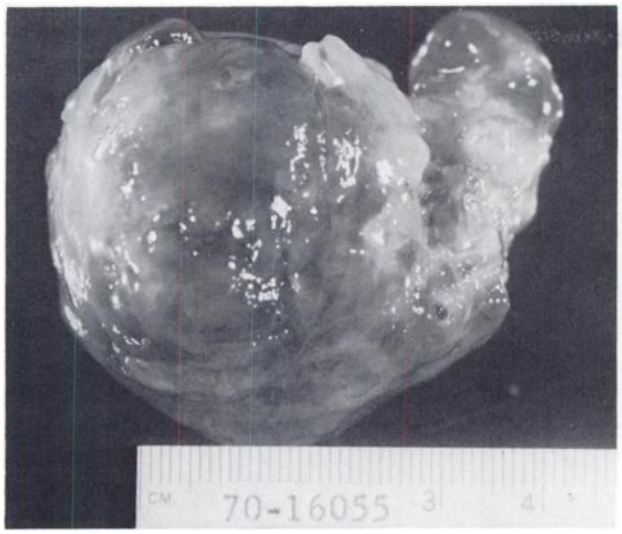

FIG. 4. Removed surgical specimen. Tumor stalk is seen in upper right.

eight patients with mitral valve disease who were screened with the scintiphotographic technique. Results were confirmed by either cardiac catheterization or echocardiography.

DISCUSSION

This scintiphotographic technique offers an alternative safe noninvasive means of demonstrating left atrial myxoma. To our knowledge, this is the second reported demonstration of left atrial myxoma by radioisotope techniques (*12*). The tumor can be detected in the ungated radionuclide angiocardiogram as was the case in the patient described by Kriss, et al (*12*) (Fig. 1); but it may be better defined in the gated study (Fig. 2). Demonstration of the tumor within the ventricle during end-diastole but not in ventricular systole illustrates the usefulness of the gated technique in assessing tumor motion. The tumor was not clearly detected in the left atrium during gated end-systolic imaging. This is probably due to dense overlying activity in the aortic root and pulmonary vasculature which in the right anterior oblique position might tend to obscure any atrial filling defect.

Right atrial myxoma has been previously demonstrated by rectilinear scanning in the anteroposterior position (*4,12–14*). It may be easier to detect lesions of the right atrium since there will be the least superimposed activity from other structures along the lower right heart border. Using radionuclide angiocardiography Steiner, et al detected metastatic involvement of the right ventricle with adenocarcinoma. On sequential study progressive involvement by tumor was noted (*15*). Staub has also recently demonstrated the presence of right atrial metastases with radionuclide angiocardiography. In this instance, the defect was not seen on the rectilinear heart scan (*16*).

Several other noninvasive techniques have been used in the diagnosis of left atrial myxoma. The phonocardiogram which may demonstrate an early diastolic sound ("tumor plop"), a prominent first heart sound, and variable systolic and diastolic murmurs (*17,18*) was not characteristic in this patient. The apexcardiogram which may demonstrate a notch on the systolic upstroke corresponding to ejection of tumor from the left ventricle (*19,20*) could not be obtained because of the emphysematous chest deformity. The echocardiogram which shows a characteristic pattern in the presence of left atrial myxoma (*21*) was not obtained in this patient. However, in the presence of severe emphysema it may be difficult to obtain an adequate ultrasound record (*22*).

SUMMARY

A left atrial myxoma was detected in a noninvasive manner using the Anger scintillation camera. Following the intravenous bolus injection of ^{99m}Tc-human serum albumin, the tumor was detected by both radionuclide angiocardiography and ECG gated cardiac imaging. With ECG-gating of the camera an end-systole and end-diastole tumor motion could be assessed.

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REFERENCES

1. Goodwin JF: Diagnosis of left atrial myxoma. *Lancet* 1: 464–468, 1963

2. Greenwood WF: Profile of atrial myxoma. *Amer J Cardiol* 21: 367–375, 1968

3. Marpole DGF, Kloster FE, Bristow JD, et al: Atrial myxoma, a continuing diagnostic challenge. *Amer J Cardiol* 23: 597–602, 1969

4. Zitnik RS, Giuliani ER: Clinical recognition of atrial myxoma. *Amer Heart J* 80: 689–700, 1970

5. Anger HE, Van Dyke DC, Gottschalk KA, et al: The scintillation camera in diagnosis and research. *Nucleonics* 23: No 6, 57–62, 1965

6. Strauss HW, Zaret BL, Hurley PJ, et al: A scintiphotographic method for measuring left ventricular ejection fraction in man without cardiac catheterization. *Amer J Cardiol.* In press

7. Zaret BL, Strauss HW, Hurley PJ, et al: Left ventricular ejection fraction and regional myocardial performance in man without cardiac catheterization. *Circulation* 42: Suppl, 3: 364, 1970

8. ZARET BL, STRAUSS HW, HURLEY PJ, et al: A noninvasive scintiphotographic method for detecting regional ventricular dysfunction in man. *New Eng J Med* 284: 1165–1170, 1971

9. HURLEY PJ, STRAUSS HW, WAGNER HN: Radionuclide angiocardiography in the diagnosis of right to left shunts. *Johns Hopkins Med J* 127: 46–54, 1970

10. GRAHAM TP, GOODRICH JK, ROBINSON ME, et al: Scintiangiocardiography in children. *Amer J Cardiol* 25: 387–394, 1970

11. OLDENDORF HW: Measurement of the mean transit time of cerebral circulation by external detection of an intravenously injected radioisotope. *J Nucl Med* 3: 382–398, 1962

12. KRISS JP, ENRIGHT LP, HAYDEN WG, et al: Radioisotopic angiography: wide scope of applicability in diagnosis and evaluation of therapy in diseases of the heart and great vessels. *Circulation* 43: 792–808, 1971

13. ISLEY JK, CURRY TS: Intracardiac myxoma demonstrated on vascular scan. *Amer J Roentgen* 88: 70–72, 1962

14. BONTE FJ, CURRY TS: Tc^{99m} human serum albumin blood pool scan diagnosis of an intracardiac myxoma. *J Nucl Med* 8: 35–39, 1967

15. STEINER RM, BUSS MI, KUMPEL F, et al: The diagnosis of intracardiac metastasis of colon carcinoma by radioisotope and roentgenographic studies. *Amer J Cardiol* 26: 300–304, 1970

16. STAUB RT: Tumor thrombus of the right atrium displayed by rapid sequence scintiphotography. *J Nucl Med* 11: 559–560, 1970

17. PITT A, PITT B, SCHAEFER J, et al: Myxoma of the left atrium: hemodynamic and phonocardiographic consequences of sudden tumor movement. *Circulation* 36: 408–416, 1967

18. ZITNIK RS, GIULIANI ER, BURCHELL HG: Left atrial myxoma: phonocardiographic clues to diagnosis. *Amer J Cardiol* 23: 588–591, 1969

19. HASHIBA K, ONO A, MATSUO S, et al: Apexcardiogram and phonocardiogram in the diagnosis of left atrial myxoma. *Jap Heart J* 11: 202–211, 1970

20. BECKER LC, CONTI CR: Left atrial myxoma: evidence of tumor movement by apexcardiogram. *Chest* 60: 280–282, 1971

21. WOLFE SB, POPP RL, FEIGENBAUM H: Diagnosis of atrial tumors by ultrasound. *Circulation* 39: 615–622, 1969

22. FEIGENBAUM H, ZAKY A, WALDENHAUSEN JA: Use of ultrasound in the diagnosis of pericardial effusion. *Ann Intern Med* 65: 443–452, 1966