process of identification occurs when one approaches the right or left main bronchus. All segments on the display board are represented by a red and green light aligned side by side in each respective segment. As soon as the tip of the bronchoscope approaches within 2 mm of the sensor in the model of the lung, it will activate the electronically integrated circuitry, in turn activating the two lights on the display board. This indicates that the tip of the bronchoscope is wedged into the distal end of the segmental orifice. As the bronchoscope is withdrawn from that particular segment, the memory information on the display board will continue to register a red light but at the same time will turn off the green light. This signifies that the student has already explored the area. The system of sequential memory retention operates throughout the entire tracheobronchial tree.

The model may be used for instruction with either an open bronchoscope or a flexible fiberoptic bronchoscope. It is necessary to thoroughly lubricate the bronchoscope with silicone spray to facilitate better maneuverability of the bronchoscope and to prevent damage to the deflecting mechanisms.

The practice of bronchoscopic technique becomes particularly rewarding for the student if two individuals participate at the same time. One may operate the bronchoscope while the other notes the score on the electronic integrated board.

Echophonocardiographic Diagnosis of Left Ventricular Pseudoaneurysm*

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We report the presence of an unusual systolic murmur associated with a traumatic left ventricular pseudoaneurysm. Echophonocardiographic studies showed the murmur to begin at the first heart sound, but end well before the second heart sound. It seems likely that the murmur is caused by the systolic flow of blood from the left ventricle into the relatively noncompliant pseudoaneurysm. The echocardiographic scan of the left ventricle demonstrated a relatively echo-free space posterior to the left ventricular wall, supporting the diagnosis of pseudoaneurysm, which was confirmed with angiographic studies and at surgery. These findings indicate that a combination of noninvasive techniques is useful in establishing this diagnosis.

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Pseudoaneurysms occur following rupture of the myocardium due to infarction,1-3 surgery,4 or trauma,5 when the resulting hematoma is contained within a circumscribed area of the pericardial space. While true aneurysms arise from the ventricular wall and are composed of myocardial scar tissue, the walls of pseudoaneurysms are not formed from myocardium and are composed of fibrous tissue only; consequently, they carry a high risk of sudden rupture.1-3 Now that surgical treatment is available for this condition,4-7 the recognition of pseudoaneurysms has become increasingly important. The present report describes the unusual features of a systolic murmur in a patient with a traumatic pseudoaneurysm. Recognition of these features may be useful when considering this diagnosis.

CASE REPORT

A 20-year-old man was admitted to the hospital with a two-week history of intermittent sharp substernal chest pain. Six years previously, he had been attacked by six men and severely kicked in the head and chest. There were no immediate sequelae, but six months later, the patient experienced a two-week illness characterized by fever and retrosternal chest pain. At that time, no murmur or rubs were heard, but cardiomegaly was noted on the chest x-ray film. The patient subsequently remained free of symptoms until the present illness.

Physical examination on admission showed a healthy black man in no acute distress. A sustained systolic precordial impulse was palpable from the right parasternal area to the left anterior axillary line. There was an apical systolic thrill. The first and second heart sounds were normal. No third or fourth heart sounds were heard. There was a grade 4/6 early to middysystolic murmur heard loudest at the mitral area,

|FIGURE 1. Part of chest x-ray film taken in right anterior oblique projection showing thin rim of calcification at apex of heart. Arrows indicate gap in calcification, through which left ventricular cavity was shown by angiogram to communicate with pseudoaneurysm. |
which radiated widely to the precordium and back.

The chest x-ray film showed cardiomegaly, which appeared to be primarily confined to the left ventricle, with a thin oval ring of calcification at the apex of the heart (Fig 1). There was no evidence of pulmonary congestion. The electrocardiogram showed deep symmetric inversion of the T waves in leads 1, 2, 3, aVF, and V₅ to V₆. Following the phonocardiographic and echocardiographic studies discussed subsequently, cardiac catheterization was performed. The right and left ventricular pressures were normal, with the exception of a left ventricular end-diastolic pressure of 14 mm Hg. The left ventriculogram showed an aneurysm approximately 9 cm in diameter, arising from the inferior surface of the heart and filling from the left ventricular cavity through a neck 1 cm in diameter (Fig 2). There was no mitral regurgitation, and the ascending aortogram and coronary angiograms were normal.

At thoracotomy an extensive pseudoaneurysm was found indivisibly adherent to the inferior and lateral walls of the left ventricle. The aneurysm consisted of two compartments, one of which was filled with blood and thrombus and the other with serous fluid. Under cardiopulmonary bypass the communication between the ventricle and the pseudoaneurysm was closed, and the pseudoaneurysm was partially resected. After surgery the systolic murmur was no longer present, and the patient made an uneventful recovery.

Noninvasive Studies

Using echocardiographic studies to time its start and finish, the features of the murmur are illustrated in Figure 3. The echophonocardiogram of the mitral valve reveals that the systolic murmur started so early in systolic systole that it could not be separated from the first heart sound. The echophonocardiogram of the aortic valve (Fig 3) shows that at the moment of full opening of the cusps of the aortic valve, when ejection murmurs commence, the murmur in this patient has fully developed. Thus, at the start of systole, the typical features of a pansystolic murmur were present; however, in the latter half of systole, it is clear that the murmur finishes well before the second heart sound, the characteristic of an ejection or "flow" murmur (Fig 3). The configuration of this murmur, which combined both pansystolic and ejection systolic features, may be explained by the following hypothesis. As soon as ventricular pressure developed, blood entered the pseudoaneurysm through the narrow neck, resulting in turbulent flow and causing the murmur. Because the pseudoaneurysm was relatively noncompliant, equalization of pressure between the cavities of left ventricle and pseudoaneurysm occurred before the end of systole, halting the flow of blood and abbreviating the murmur in late systole.

A murmur with a similar configuration may also occur in acute mitral regurgitation,⁸ where a comparable hemodynamic situation exists. In this situation the left atrium is the noncompliant chamber, and the regurgitant flow during systole leads to a rise in left atrial pressure and a loss of gradient between the left ventricle and atrium during late systole, with consequent attenuation of the murmur. Acute mitral regurgitation is therefore an important differential diagnosis of the cause of this murmur. A muscular ventricular septal defect could also produce a similar murmur.

In the present case, echocardiographic studies provided valuable additional information to suggest the diagnosis of pseudoaneurysm. Scanning the left ventricle towards the apex demonstrated a relatively echo-free space lying posterior to the left ventricular wall but anterior to the pericardium (Fig 4). Extreme caudal angulation of the transducer was required to detect this abnormality, and, therefore, the structure labelled posterior wall in the echocardiogram in Figure 4 probably represented the inferior surface of the heart corresponding with the location of the pseudoaneurysm. Possible causes for this echocardiographic abnormality include pseudoaneurysm, a loculated posterior pericardial effusion,⁸ or a posterior mediastinal cyst. In view of the differ-
ential diagnosis established from the combined echophonocardiographic studies, it was clear that a pseudoaneurysm was the only diagnosis that would satisfactorily explain all of these observations.

DISCUSSION

Until recently, the diagnosis of pseudoaneurysm of the left ventricle was seldom made prior to cardiac catheterization, surgery, or autopsy. The history, physical examination, chest x-ray film, and ECG often suggest the diagnosis of left ventricular aneurysm, but it has been difficult or impossible to distinguish true from false aneurysms without left ventricular angiographic studies. This distinction is extremely important because pseudoaneurysms, unlike true aneurysms, are prone to sudden rupture and are now amenable to successful surgical resection. Recently, the diagnosis of pseudoaneurysm has been facilitated by new noninvasive techniques. Roelandt et al7 demonstrated an echo-free space posterior to the left ventricle in a patient with pseudoaneurysm, which helped to establish the diagnosis. Botvinick et al,10 using radioisotopic gated imaging of the cardiac blood pool, were able to demonstrate a separate chamber in a patient with left ventricular pseudoaneurysm and to establish the diagnosis prior to angiographic studies.

Our report describes the echophonocardiographic features of an unusual systolic murmur, which may provide a valuable diagnostic sign to suggest the presence of a left ventricular pseudoaneurysm. Previous reports of pseudoaneurysms10,11 have alluded to the presence of a systolic murmur at the apex, the murmur being variously described as early, ejection, or pansystolic, but the precise characteristics have not been defined. We believe that the echophonocardiographic features of the murmur in our patient, which showed early pansystolic but late systolic ejection features, may be characteristic of this condition. The only previously published phono-

![Figure 4. Echocardiographic scan of left ventricle, showing relatively echo-free space which represents pseudoaneurysm (PA), lying between posterior ventricular wall (PW) and pericardium (PERI). IVS, Interventricular septum.](image)

cardiogram in pseudoaneurysm would support this hypothesis.11 Our report also confirms the echocardiographic abnormality seen on the left ventricular scan in left ventricular pseudoaneurysm. This case illustrates the fact that by using a combination of noninvasive techniques, the diagnosis of left ventricular pseudoaneurysm may be made prior to angiographic studies.

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