Late Systolic Murmur: A Clue to the Diagnosis of Aneurysm of the Membranous Ventricular Septum*

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A patient with a "late systolic" murmur along the left sternal border was found to have an aneurysm of the membranous interventricular septum with a small left-to-right shunt through the dome of the aneurysm. A left ventricular cineangiogram, which delineated the nature of this shunt, helps to explain the auscultatory findings. Four other patients with this defect and a similar murmur have been reported. It is proposed that this murmur may be a clue to the clinical diagnosis in some patients with interventricular septal aneurysms.

A murmur whose major vibrations are confined to the latter half of systole has been noted in such diverse clinical states as subaortic stenosis, Marfan's syndrome, and in patients with pericarditis. Most commonly, however, a "late systolic murmur" is heard near the cardiac apex in association with a prolapsing posterior mitral valve leaflet and mild mitral insufficiency, or in some patients with coronary artery disease and papillary muscle dysfunction.

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We recently studied a patient with a systolic murmur which began just after the first heart sound and which was most intense in the third and fourth intercostal spaces along the left sternal border. The majority of the sound vibrations were confined to the latter half of systole with marked accentuation prior to the second heart sound. This patient was found to have an aneurysm of the membranous ventricular septum with a small left-to-right shunt through the dome of the aneurysm. Angiographic evaluation demonstrated certain characteristics of this shunt which account for the unusual murmur. A review of the literature reveals at least four other similar cases and indicates that this auscultatory pattern may be a clinical clue to the diagnosis of some patients with perforated ventricular septal aneurysms.

**CASE REPORT**

The patient, a 34-year-old man, was seen at The University of Texas Medical School at San Antonio-Bexar County Teaching Hospital because of intermittent precordial chest pain and a heart murmur. The murmur had been noted at least 13 years previously. He had no significant cardiovascular complaints as the chest pain was atypical and not believed to be of cardiac origin. No history of any preceding cardiovascular illness or abnormality could be elicited.

The result of his physical examination was unremarkable except for his cardiac findings. No precordial abnormalities were visible; no right or left ventricular impulse was palpated and there was no thrill. Normal inspiratory splitting of his second heart sound was heard and no third or fourth heart sound was present. Along the left sternal border (maximum

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**Figure 1.** Electrocardiogram (ECG), phonocardiogram at the third left intercostal space (3LICS) adjacent to the sternum, carotid pulse tracing (CPT), and apex cardiogram (ACG). A systolic murmur begins just after the first heart sound ($S_1$) and progressively increases in intensity reaching a peak immediately prior to the second heart sound ($S_2$).
in the third and fourth intercostal spaces), a grade III-IV, on a scale of VI, systolic murmur was heard (Fig 1). This murmur began just after the first heart sound and progressively increased in intensity, reaching a peak in late systole, immediately prior to the second heart sound. No systolic click was noted on auscultation or phonocardiography. The murmur decreased in intensity with amyl nitrate administration and increased in intensity with phenylephrine (Neo-Synephrine) infusion. The electrocardiogram and chest x-ray films were normal.

Although this man’s murmur first suggested the diagnosis of mitral valve prolapse with mild mitral insufficiency, the absence of a systolic click, and especially its location along the left sternal border, were atypical features. Therefore, in order to make a definitive diagnosis, cardiac catheterization and angiography were carried out. These studies disclosed entirely normal right and left heart pressures. Although an oxygen series was normal, dye curves which utilized right and left heart injections and sampling indicated a small left-to-right shunt at the ventricular level. A left ventricular cineangiogram taken in the left anterior oblique projection, demonstrated a small aneurysm of the membranous interventricular septum which had a small left-to-right shunt through several small openings in its dome. During systole the aneurysm increased in size from approximately 1.5 to 2.5 cm. Although some contrast material passed into the right ventricular outflow tract with the initiation of systole, the left-to-right shunt was most prominent during late systole. No mitral regurgitation was present.

**DISCUSSION**

Aneurysms of the membranous portion of the interventricular septum are relatively rare lesions and probably of congenital origin. They generally do not have any distinguishing clinical features, and therefore, the diagnosis has usually been made at autopsy, during surgery, or from left ventricular angiography.10-20 In most cases, another congenital cardiac defect has been present and the auscultatory features are those associated with the latter lesion. Most often there has been a small left-to-right shunt through perforations in the aneurysm and auscultation indicates a ventricular septal defect. A moderate intensity, rough pansystolic murmur, accompanied by a thrill, may be heard along the left sternal border, but occasionally only a mid-systolic murmur, or both murmurs, are noted.10-13 Ventricular septal aneurysms, which are not perforated, may cause no murmur at all or be associated with a number of non-specific murmurs generated within the aneurysm itself, by protrusion of the aneurysm into the outflow tract of the right ventricle or by impinging upon the septal leaflet of the tricuspid valve.14-17 Several recent reviews may be consulted regarding further features of these defects.10,11,16

When our patient was first evaluated, his late systolic murmur (Fig 1) suggested the diagnosis of a prolapse of a mitral valve leaflet with mild mitral insufficiency; however, his murmur was most intense along the left sternal border in the third and fourth interspaces (similar to a ventricular septal defect), and barely heard at the apex, which is the usual site for the mitral murmur.5-8 There was no clinical evidence to incriminate any other disease process.1-4,9 Cardiac catheterization was performed to clarify his problem and angiography disclosed a septal aneurysm with a small left-to-right shunt (Fig 2).

Because of the unusual auscultatory features in this patient, a review of the pertinent literature was carried out and four patients with this defect and late systolic type (major vibrations during the latter half of systole) murmurs were found. In two patients, an isolated septal aneurysm was present. In case No. 3 of Larsen and Noer14 a “thin sibilant murmur was noted in late systole” in the second left interspace. At autopsy, a 12 x 20 to 25 mm aneurysm of the membranous septum protruded into the tricuspid orifice and seemed to elevate the septal leaflet of the valve. This effect upon the tricuspid valve was believed to be the origin of the murmur, possibly through the production of tricuspid valvular insufficiency in late systole. Lekisch15 reported a patient with a “grade III late systolic murmur. High pitched and of musical type, it was best heart over the apex and along the left sternal border.” No explanation for the late systolic characteristics of the murmur was offered.

In the present case, plus two recently reported by Pombo and associates,18 the aneurysm of the septum was associated with a small left-to-right shunt. In Pombo’s cases, the “late systolic accentuation” of the systolic murmurs was noted along the left sternal border and in the pulmonary area. They theorized that the late systolic accentuation was secondary to obstruction to the right ventricular outflow tract brought about by impingement...
of the aneurysm in this area during systole. Although right ventricular outflow obstruction has been demonstrated in some patients with a ventricular septal aneurysm, these patients have not had late systolic murmurs or late systolic accentuation.\textsuperscript{10,20}

Furthermore, no patients with late systolic murmurs have shown significant outflow tract obstruction.\textsuperscript{15,18} The presence of the aneurysmal sac in the right ventricular outflow tract could, however, generate a sound without producing hemodynamically significant obstruction.

A review of the left ventricular cineangiogram in our patient disclosed certain features that explain the auscultatory findings independent of any outflow tract impingement. These are shown diagrammatically in Figure 3. As systole begins (Fig 3 A), the aneurysm is approximately 1.5 cm in diameter and a small amount of blood passes through several perforations in the dome of this structure into the right ventricular outflow tract. This accounts for the early small vibrations after the first heart sound (Fig 1). As systole continues, the aneurysm increases in size (Fig 3 B, C), eventually reaching about 2.5 cm, and a progressively greater amount of blood passes through the dome into the right ventricle. This progressive increase in flow through the aneurysm correlates with the progressive increase in the intensity of the murmur, the greatest flow which occurs in late systole, results in late systolic accentuation of the murmur. The reason for the progressive increase in flow is unknown, but may be related to stretching of the small defects in the dome as the aneurysm increases in size. In patients with no left-to-right shunt, this explanation is not valid, but the previously mentioned outflow tract effects or deformation of the tricuspid valve may occur and produce tricuspid insufficiency analogous to late mitral insufficiency.\textsuperscript{2,5,8,21}

Since aneurysm of the membranous septum has no specific clinical features which might aid in its diagnosis, any clinical clues stimulating our awareness of this entity would be helpful. A late systolic murmur or a murmur with prominent late systolic accentuation, which is primarily heard along the left sternal border, appears to be such a clue. To make the definitive diagnosis, cardiac catheterization and left ventricular angiography may be employed.

**REFERENCES**

17 Steinberg I: Diagnosis of congenital aneurysm of ventricular septum during life. Brit Heart J 19:8-12, 1957

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ANNOUNCEMENTS

Postgraduate Courses in Bronchoesophagology

The Department of Laryngology and Bronchoesophagology, Temple University Hospital and School of Medicine, Philadelphia, will present Postgraduate Courses in Bronchoesophagology under the direction of Drs. Charles M. Norris and Gabriel F. Tucker, Jr. The courses will be held November 1-12, 1971 and February 28-March 10, 1972. Application and further information may be obtained by writing the Chevalier Jackson Clinic, Temple University Hospital, 3401 North Broad Street, Philadelphia 19140.

Postgraduate Course: Clinical Chest Diseases

Drs. Louis E. Siltzbach, Robert S. Litwak, Irving J. Selikoff and associates, will direct a Postgraduate Course on Clinical Chest Diseases at the Mount Sinai Hospital, New York City, November 8-12. Sponsor of the course is the Department of Internal Medicine, Mount Sinai School of Medicine of the City University of New York, Page and William Black Postgraduate School of Medicine. The course will present a comprehensive review of current diagnostic and therapeutic practices in the field of chest diseases. For application and information, write the Registrar, Page and William Black Postgraduate School of Medicine, Fifth Avenue and 100th Street, New York City 10029.

International Symposium on Recent Advances in Cardiac Arrhythmias

An International Symposium on Recent Advances in Cardiac Arrhythmias will be presented at the University Department of Cardiology and Clinical Physiology, Wilhelmina Gasthuis, Amsterdam, Netherlands, March 23-24, 1972. For information, please write Dr. D. Durrer, Wilhelmina Gasthuis, Amsterdam, Netherlands.

Refresher Course: Clinical Aspects of Electrocardiography and Vectorcardiography

The University of Chicago will present a refresher course on "Clinical Aspects of Electrocardiography and Vectorcardiography" (including pediatric aspects) in the Center for Continuing Education, University of Chicago, January 17-22, 1972. The course will be given by the Section of Cardiology, Department of Medicine, and will be under the direction of Drs. R. W. Childers and Hans H. Hecht. Direct all inquiries to Mr. Claude Weil, Center for Continuing Education, University of Chicago, 1307 East 60th Street, Chicago 60637.