THE PHONOCARDIOGRAM OF AORTIC STENOSIS

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Aortic stenosis produces a systolic murmur of characteristic shape in the phonocardiogram both in the aortic and mitral areas. Sound records were taken in 20 patients with aortic stenosis. The phonocardiograph used for this investigation has been described elsewhere (Leatham, 1949), and consisted of crystal microphones, valve amplifiers, and both string and mirror galvanometers. Filters were used to reduce the intensity of the low frequencies to about the same extent as effected by the human hearing mechanism; the resulting curve is called high frequency or logarithmic (Rappaport and Sprague, 1941). Records from the aortic and mitral areas were often made simultaneously. In each patient there was good clinical evidence of aortic stenosis and in 13 of them calcification of the aortic valve was seen on fluoroscopy. Any patient with a mitral diastolic murmur, whether audible or recorded by the phonocardiograph, or with radiological evidence of left auricular enlargement was excluded from the series.

The onset, shape, and termination of the systolic murmurs in these patients are represented by the diagram in Fig. 1, and phonocardiograms are shown in Fig. 2 to 6. The exact moment of onset of a systolic murmur is difficult to determine for it may be confused with high frequency components of the first sound, but appeared to start immediately after the first sound in some or later in others, as pointed out by Evans (1947). In 19 of the 20 cases in the present investigation the vibrations were small at first, rose to a peak in mid-systole, and then diminished in size until they were small or absent before the second sound; in one subject (Case 10) the accentuation was earlier in systole. This symmetrical pattern with mid-systolic accentuation was usually best seen in the aortic area, but was always present in the mitral area too. A second sound was always recorded though in some it may have been pulmonary in origin. A diastolic murmur following the second sound was heard and recorded in 13 subjects. An aortic systolic murmur of the shape described does not occur in stenosis only, for it is found in aortic sclerosis, coarctation of the aorta, and syphilitic aortic incompetence (Fig. 7).

The systolic murmur of mitral valve disease was found to be of different shape. It usually started immediately after the first sound and continued to the second sound with no sharp mid-systolic accentuation (Fig. 8 and 9). In some patients with mitral incompetence the murmur was mainly in late systole.

In pulmonary stenosis the systolic murmur was usually different from that in aortic stenosis. There was less mid-systolic accentuation and the murmur extended to the second sound or beyond it (Fig. 10).

DISCUSSION

It is known that the systolic murmur of aortic stenosis may be loud at the mitral area and even louder here than in the aortic area. Graphically, the murmur is the same in both areas, emphasizing the good conduction of sound from the aortic valve to the mitral area. When a systolic murmur is

louder at the mitral area than at the aortic area, as it was thrice in this series, mitral valve disease may be suspected, but the phonocardiogram can differentiate the two.

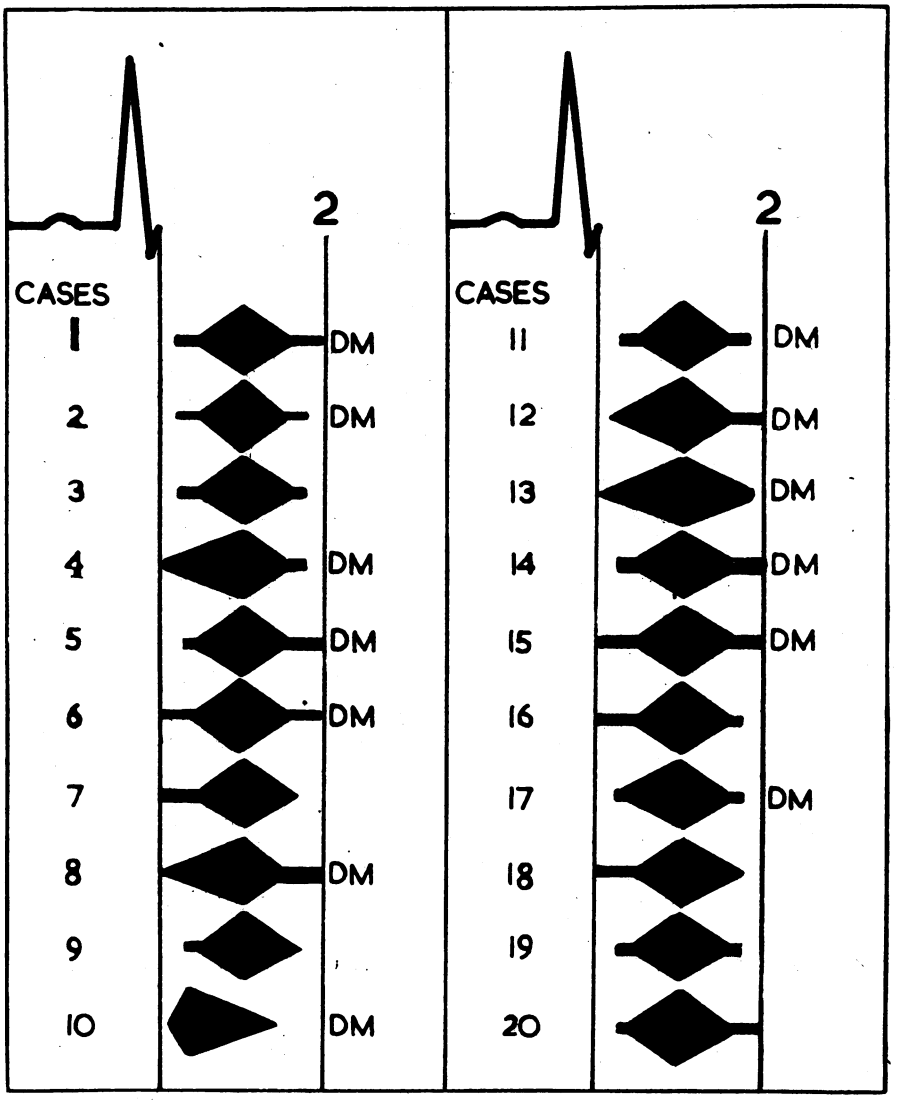

FIG. 1.—Diagram showing the murmurs of aortic stenosis in 20 patients. The systolic murmur is related to the electrocardiogram and to the second heart sound. There is an aortic diastolic murmur (DM) in 13 patients.

It is strange that there is usually a difference between the systolic murmurs of aortic and pulmonary stenosis. In the phonocardiogram of a patient with pulmonary stenosis (Fig. 10) the second sound recorded at the mitral area is probably aortic in origin. The systolic murmur in the pulmonary area reaches this second sound and extends beyond it into diastole. This might be regarded as a pulmonary diastolic murmur. Another explanation is delay in termination of right ventricular systole and continuation of the pulmonary systolic murmur beyond the aortic second sound. This murmur might finish before a late pulmonary second sound which would then bear the same relation to a pulmonary systolic murmur as the aortic second sound and systolic murmur in aortic stenosis. Unfortunately a pulmonary second sound can seldom be demonstrated in pulmonary stenosis.

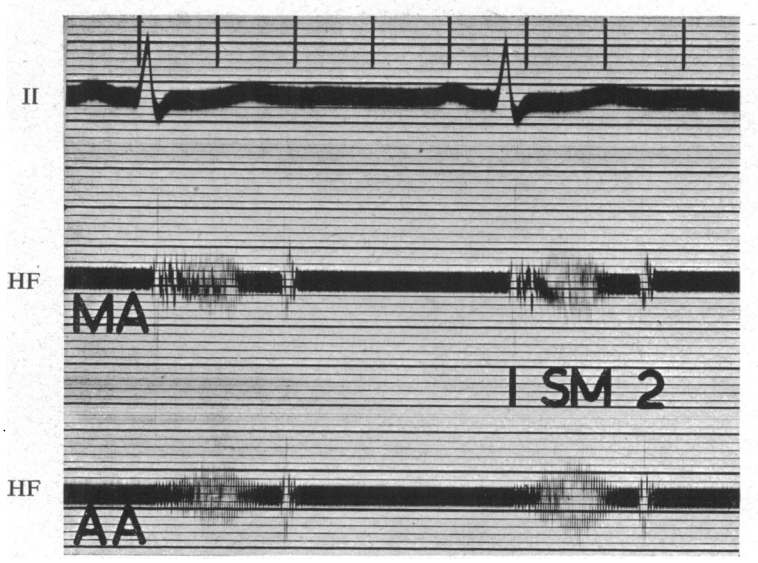

FIG. 2.—Aortic stenosis. The systolic murmur starts soon after the first sound, rises to a peak about mid-systole, and diminishes before the second sound. The murmur has the same shape in synchronous high frequency records (HF) from the mitral area (MA) and aortic area (AA). The time interval in this and subsequent records is 1/5 sec.

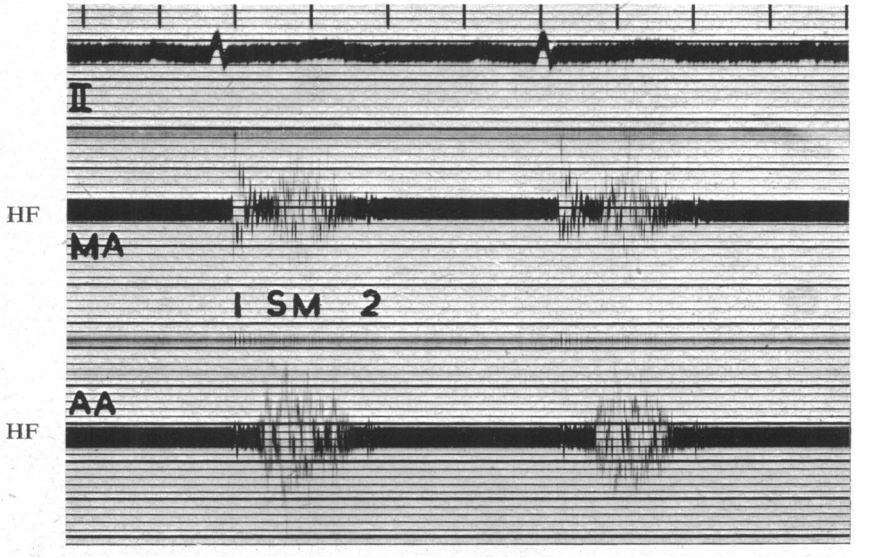

FIG. 3.—Aortic stenosis (see Fig. 2).

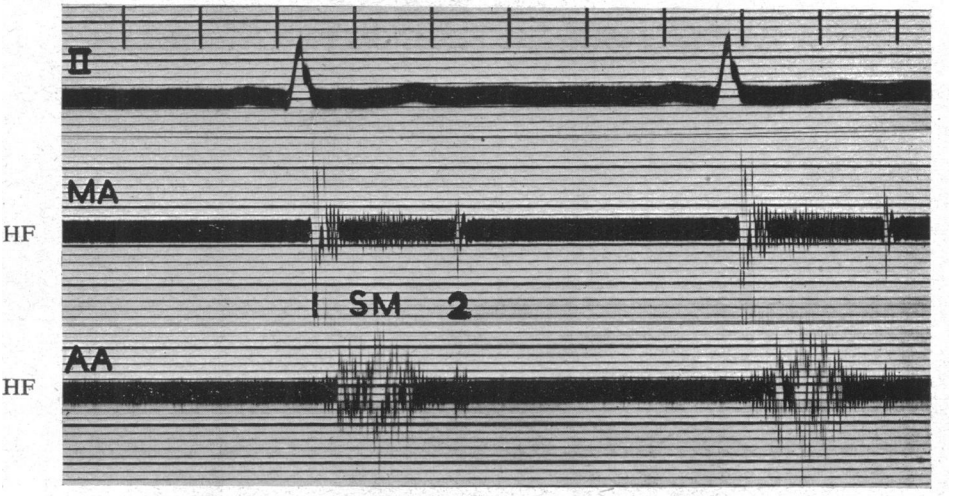

FIG. 4.—Aortic stenosis.

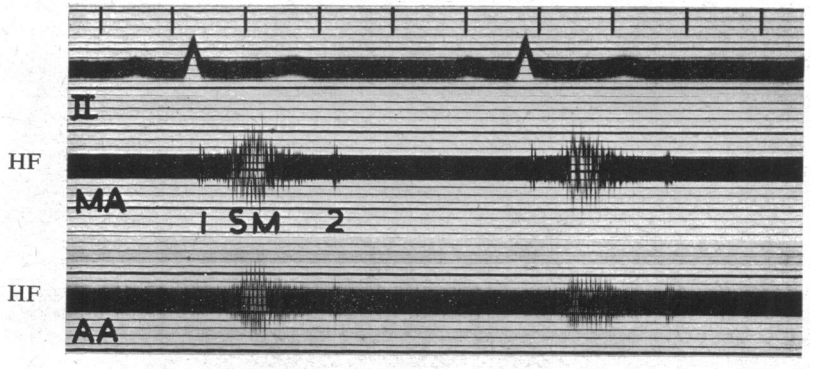

FIG. 5.—Aortic stenosis.

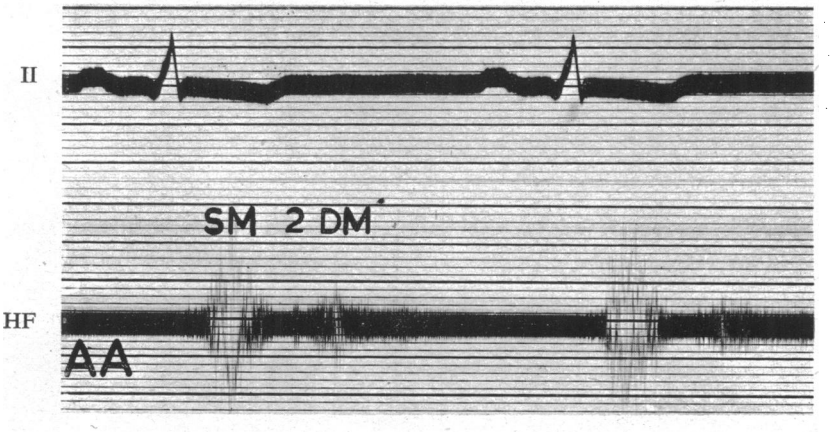

FIG. 6.—Aortic stenosis and incompetence.

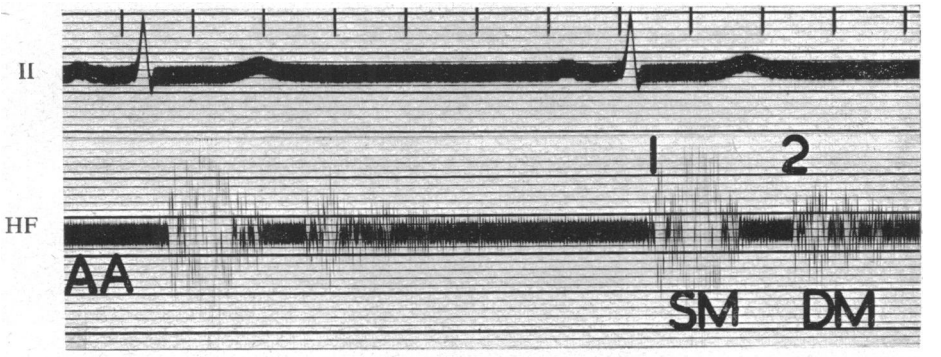

FIG. 7.—Syphilitic aortic incompetence. The systolic murmur has the same shape as in aortic stenosis.

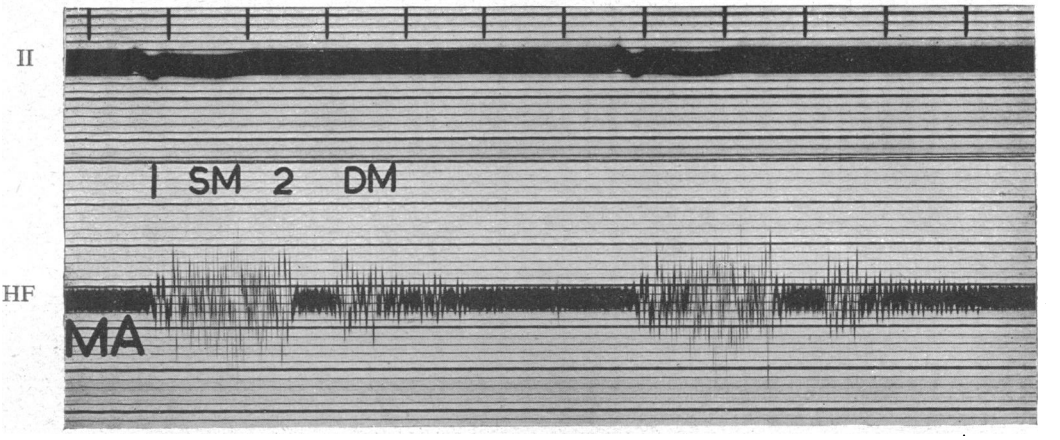

FIG. 8.—Mitral valve disease with auricular fibrillation. The systolic murmur fills systole between the first and second sounds. There is a mitral diastolic murmur (DM).

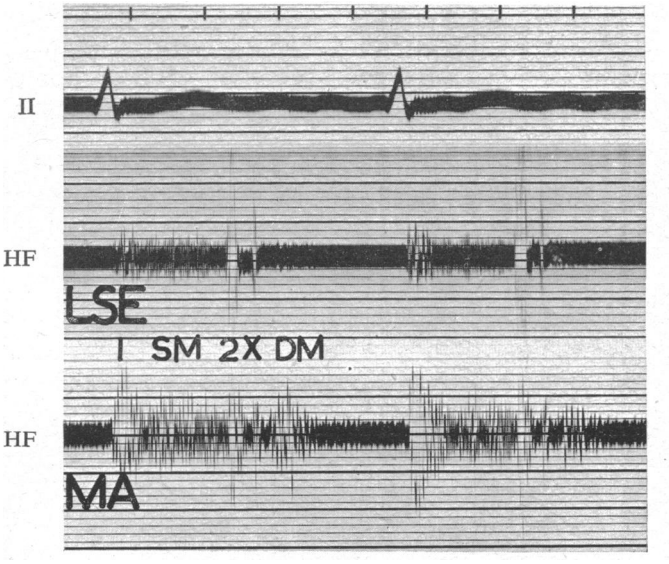

FIG. 9.—Mitral valve disease with auricular fibrillation. The systolic murmur fills systole. There is an "opening snap" (X) loudest at the lower left sternal edge (LSE), and a mitral diastolic murmur.

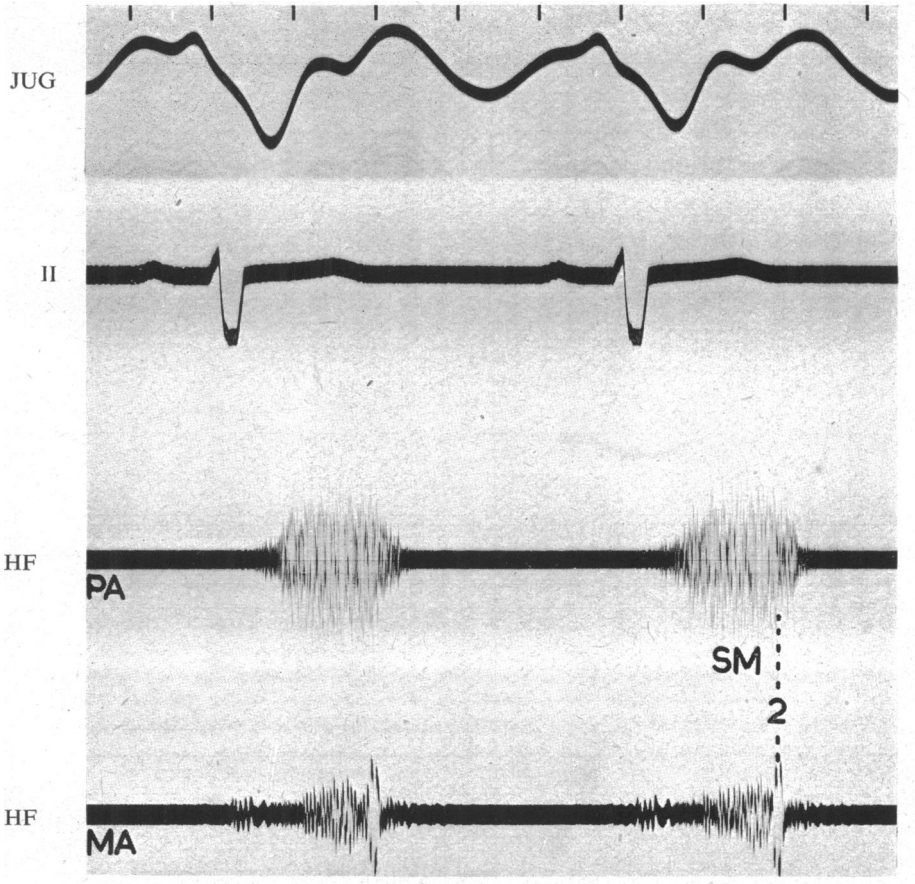

FIG. 10.—Pulmonary stenosis. The murmur in the pulmonary area (PA) extends beyond the second sound recorded at the apex (MA).

CONCLUSION

The phonocardiogram of aortic stenosis shows a systolic murmur of characteristic shape both in the aortic and mitral areas. The murmur is small at first, rising to a peak in mid-systole and then decreasing so that it is small or absent before reaching the second sound. In mitral valve disease the systolic murmur tends to fill systole more evenly or to be mainly in late systole, while in pulmonary stenosis the systolic murmur usually extends to the second sound.

NOTE: Since this communication was given to the British Cardiac Society in June, 1949, Dr. S. A. Levine in "Clinical Auscultation of the Heart" (W. B. Saunders Co., Philadelphia and London, 1949) has described the systolic murmur of aortic stenosis as of diamond shape in the phonocardiogram. He writes that "The form of the sound tracing has been so constant that we have wondered whether it might be helpful diagnostically. It appears that the systolic murmur of mitral insufficiency, from which it needs to be differentiated, takes on a different form, having a plateau, diminuendo, or crescendo configuration."

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