CONTRARY to the opinion of older clinicians diastolic murmurs are not always organic. This is demonstrated especially by the experiences we made with amplifier auscultation. Such non-organic murmurs may be produced by annular incompetence of a valve or by increased blood flow across a normal valve.

The murmurs generated by such mechanisms in this report will be designated as "functional" to avoid confusion with organic and adventitious murmurs.

Special kinds of functional diastolic murmurs are for instance Graham Steell murmur in patients with mitral stenosis and Austin Flint murmur associated with aortic valvular insufficiency.

Since 1961 another mechanism of generation of functional diastolic murmurs across intact valves purely by means of hemodynamic alterations due to tachycardia was described by Wolf. He found such murmurs in healthy children with tachycardia. When the heart rate became normal the murmur disappeared. This was confirmed later on by Zeh in adults.

Two theories have been proposed to explain the mechanism of the production of Wolf's murmur, (1) when the rapid filling time and the augmentation of inflow velocity by auricular contraction coincide. This may be a true functional "stenosis" of either or both A-V valves. (2) The other possibility is a form of summation gallop. But since the murmur lasts for about 0.20 sec. the IV sound should follow the III sound immediately. That means it is more a follow-up than a summation gallop.

A 58-year-old diabetic woman with arteriosclerotic coronary heart disease was admitted to our hospital because of a low pulse rate. There was no history of rheumatic fever, chorea, or heart disease.

On physical examination the heart rate was 40/min. The blood pres-
sure was between 115/70 and 170/90 mm. Hg. The heart was enlarged to both sides. There was no cyanosis, anemia, or edema. On auscultation a loud IV sound was heard over the area of cardiac dullness shortly before the I sound which was of normal intensity. The II sound had no peculiarity. A systolic murmur of moderate intensity was heard over the apex. Shortly after the II sound there could be also heard a low-pitched murmur or an extra sound. A few fine moist rales were heard over both lung bases.

The functional capacity was slightly restricted (Class II).

The electrocardiogram showed a 2:1 A-V block with a PP interval of 0.64 sec., broad Q waves in lead III and negative T waves in leads V₂ to V₆. The white blood cell count, ESR and serum transaminases were normal. There was no suggestion of a recent myocardial infarction. The X-ray film of the chest revealed a slight enlargement of the cardiac silhouette to both sides and arteriosclerotic changes of the aorta but no calcification of any valve ring and no congestion in the lung fields.

The fasting blood sugar was 95 mg.%. The urinalysis revealed glucosuria but no albuminuria.

The phonocardiogram (Fig. 1), taken from the apical area, shows an accentuated IV sound which starts about 0.1 sec. after the beginning of the conducted P wave and fuses into the following I sound. It has normal intensi-

![Fig. 1. Tracings: Phonocardiogram h₁, m₂, m₁, t. Venous sphygmogram and Ecg II (explanation see text).](image-url)
The IV sound is well revealed in the filters \( t \) and \( m_1 \) (Maass and Weber) and also can be recognized in the filter \( m_2 \). Secondly, a diastolic murmur is registered about 0.15 sec. after the beginning of the II sound, 0.1 sec. after the onset of the non-conducted P wave, with all filters. However, with the filter \( t \) the murmur consists of 2 or 3 low frequency components, which seem to be composed of 2 low-pitched extra sounds, similar to ventricular and atrial gallop sounds. The duration of the murmur is about 0.20 sec. with the filters \( m_1 \) and \( m_2 \). The higher components of the murmur decrease over the left lower sternal border and cannot be recorded over the base of the heart.

The ventricular and venous sphygmogram show that the murmur begins

---

Fig. 2. Tracings: Phonocardiogram \( h_1, m_2, m_1, t \). Venous sphygmogram and Ecg II.

Fig. 3. Tracings: Phonocardiogram \( m_2, h_1 \) and Ecg II.

There is also 2:1 A-V block. In this case the 2 components of the follow-up gallop are more separated than in the first patient of Figs. 1 and 2.
at the ventricular rapid filling time and with the atrial contraction, which occur very closely together in this case.

For comparison with Fig. 1, the phonocardiogram was taken when sinus rhythm was present after treatment (Fig. 2). The diastolic murmur has now completely disappeared. In diastole there is only a III sound with the filter \( t \) and a IV sound which looks very similar to that of Fig. 1.

A second patient (Fig. 3) showed a similar diastolic murmur or follow-up gallop.*

**Discussion**

Although under various conditions functional diastolic murmurs simulating the diastolic murmur of mitral stenosis can be produced, it is not sure whether this is true in this case.

When the mechanism of functional mitral stenosis is involved, this murmur might be called a “Carey Coomb’s murmur”, which occurs at the beginning of diastole in the early stages of acute rheumatic valvulitis, or a variation of Wolf’s murmur.

Wolf reported that his rapid inflow murmurs were well recorded over the left lower sternal border with filters \( m_2 \) and \( h_1 \). However, in this case the low frequency components of the murmur are more dominant than the higher ones which are best recorded over the apical area. However, it has to be taken in account that our patient is 58 years old, and that she has some degree of pulmonary emphysema. Thus only low frequencies are well-conducted to the surface. (An atrial diastolic murmur, such as reported by Rytand in cases with heart block, could not be recognized in our case.)

The phonocardiographic finding in our case is somewhat different from that reported by other authors.

The predominance of the low frequency components suggests a gallop mechanism rather than a rapid filling mechanism, in spite of the fact that the conditions of such mechanisms also are fulfilled. In our observation the fact that, with a normal sinus rhythm, a conspicuous III and IV heart sound are present suggests strongly that these sounds, following one another closely, produce the impression of a diastolic murmur. The long duration of this murmur suggests that it cannot be produced by a summation gallop but rather by a “follow-up gallop”. The simulation of a diastolic murmur by such

---

* For this tracing we have to thank Dr. Jakobs of Innere Abteilung, Theresienkrankenhaus, Mannheim.
a follow-up gallop has to be considered especially in the differential diagnosis of functional diastolic murmurs, perhaps also in organic ones.

**Summary**

A "functional diastolic murmur" was observed in a patient with 2:1 A-V block. It was characterized by dominant low frequency components. With the reinstatement of sinus rhythm the murmur was replaced by its component III and IV sounds. Because of its duration it should not be designated as "summation" gallop, but rather as a "follow-up" gallop. It seems probable to us, that such a gallop may occur not only with A-V block but also with simple tachycardia.

**References**