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## Auscultation of the Heart - III

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### Abstract

The essential difference between a sound and a murmur is that the former is due to sudden alteration in the speed of blood flow whereas a murmur results from turbulence developing in the blood stream. A murmur is usually of longer duration and of higher frequency than a sound. The principal factors which influence turbulence are the velocity of flow, the density and viscosity of the blood and the diameter of the vessel. Another important factor is that a narrowed orifice, as from valvular stenosis, will give rise to eddies beyond the obstruction. A similar effect is produced by a relatively narrow vessel opening into a wider one as in dilatation of the first part of the aorta or pulmonary artery.

Murmurs may be heard in systole or diastole or may appear to be continuous throughout systole and diastole.

Diastolic and continuous murmurs are always due to organic disease but a systolic murmur may be present not only without any functional disability but without any clinical, radiographic or electrocardiographic evidence of organic heart disease.

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# AUSCULTATION OF THE HEART - III.

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## MURMURS

*Give me a calm and thankful heart,  
From every murmur free.*

—from a hymn by Anne Steele, 1760.

The essential difference between a sound and a murmur is that the former is due to sudden alteration in the speed of blood flow whereas a murmur results from turbulence developing in the blood stream. A murmur is usually of longer duration and of higher frequency than a sound. The principal factors which influence turbulence are the velocity of flow, the density and viscosity of the blood and the diameter of the vessel. Another important factor is that a narrowed orifice, as from valvular stenosis, will give rise to eddies beyond the obstruction. A similar effect is produced by a relatively narrow vessel opening into a wider one as in dilatation of the first part of the aorta or pulmonary artery.

Murmurs may be heard in systole or diastole or may appear to be continuous throughout systole and diastole.

Diastolic and continuous murmurs are always due to organic disease but a systolic murmur may be present not only without any functional disability but without any clinical, radiographic or electrocardiographic evidence of organic heart disease.

In all cases in which a murmur is heard there should be noted, as described in Part I of this paper, the area over which it is audible, the position of maximal intensity, the direction of apparent radiation, the intensity (preferably graded), the quality (using simple adjectives), and, where possible, the precise timing in systole or diastole. It should also be noted whether it is associated with a palpable thrill and if there is any abnormality of the heart sounds. In cases of doubt phonocardiography, radiography, electro-cardiography and other accessory methods of examination may be required before a firm conclusion can be drawn.

## SYSTOLIC MURMURS

Systolic murmurs may occur in association with various forms of acquired or congenital heart disease or as an isolated finding unassociated with any evidence for organic disease and may then be termed innocent, incidental or functional. A functional murmur is due to turbulence in the absence of significant structural abnormality.

However, it is not always possible to be certain that an apparently innocent systolic murmur is not due to mild organic heart disease nor, of course, from a single examination that such disease may not in time be progressive.

The chief danger is usually that of engendering anxiety and it is very important indeed to avoid this and also the imposition of unwarranted restrictions.

Infants and children must be kept under observation and examined at intervals because at this age it is quite impossible to be certain as to the nature of a systolic murmur.

In young adults it is best to arrange for re-examination after say 12 months at any rate but at the same time to give strong reassurance that no restrictions in activity are indicated and a normal life can be lead in every way.

In older patients an isolated systolic murmur can usually be ignored but it should be remembered that an aortic systolic murmur may signify valvular stenosis which does not become of dynamic importance until quite late in life, for example, after the age of 50.

### CLASSIFICATION OF SYSTOLIC MURMURS

#### INNOCENT

1. Pulmonary
2. Apical
3. Parasternal

#### ORGANIC

##### A. *Forward Flow*

1. *Aortic*  
Aortic stenosis or sclerosis  
Increased flow (Aortic incompetence)  
Coarctation of aorta
2. *Pulmonary*  
Pulmonary stenosis  
Increased flow  
Physiological  
Left to Right shunts

##### B. *Backward Flow*

- Mitral or Tricuspid incompetence
- Ventricular septal defect

### DIFFERENTIAL DIAGNOSIS OF SYSTOLIC MURMURS

If a systolic murmur can be heard its characteristics should be noted as described above and also if there is any associated thrill, diastolic murmur, change in heart sounds or other evidence for heart disease.

#### *Aortic Systolic Murmur*

The most usual cause for a systolic murmur that is loudest in the aortic area is aortic stenosis but a similar murmur may derive from sclerosis of the valve, dilatation of the ascending aorta or increased left ventricular stroke volume as in aortic regurgitation. Normally a systolic murmur may be heard just above the clavicle and occasionally it is also audible just below.

#### *Pulmonary Systolic Murmur*

The most usual cause for a systolic murmur that is loudest in the pulmonary area is normal blood flow in the young; or increased blood flow with exercise, emotion, pregnancy, anaemia, thyrotoxicosis or with a left to right shunt; or pulmonary stenosis.

*Left Parasternal Systolic Murmur*

The most usual cause for a systolic murmur that is loudest at the mid or lower left sternal border is one of the innocent varieties, tricuspid incompetence or congenital heart disease.

*Mitral Area*

The most usual cause for an apical systolic murmur is mitral incompetence or an apparently innocent murmur.

It must be remembered that the murmur of aortic stenosis may be loudest at the left sternal border or even at the apex and that a basal systolic murmur 'conducted into the neck' is not diagnostic of aortic stenosis but may be present in pulmonary stenosis or congenital heart disease. Other causes for a praecordial systolic murmur include coarctation of the aorta and patency of the ductus arteriosus in infancy or with pulmonary hypertension.

If one comes to think of it, it is remarkable that blood flow through the heart, past valves and protuberances and round bends should be so silent and not surprising that minor irregularities of no structural consequence should cause eddies associated with a murmur.

**AORTIC SYSTOLIC MURMURS**

An aortic systolic murmur may be due to aortic valvular stenosis or sclerosis, to increased blood flow across the valve or to dilatation of the ascending aorta.

*Aortic Stenosis*

Characteristically the murmur of aortic stenosis is loudest in mid-systole because this corresponds with the period of maximal blood flow.

Usually it can be appreciated by ear that the murmur ends before the second heart sound and often that there is a distinct gap between the first heart sound and the beginning of the murmur. Phonocardiographically it can be shown to be "diamond-shaped".

An aortic systolic murmur may be loudest in the "aortic area," over the sternum or down the left sternal border or sometimes even at the apex.

Unless faint it can also be heard over the carotid arteries in the neck.

Even when the murmur is not loudest to the right of the upper sternum signifying its probable source of origin it may be recognised as originating in the aortic valve because it is also well heard in this region and in the neck and because of associated features such as a systolic thrill maximal over the right upper chest, weakness or absence of the aortic second sound and from the fact that the murmur is loudest in mid-systole.

There may also, of course, be an early diastolic murmur from associated aortic incompetence.

It is important to emphasise that the loudness of the murmur bears no close relation to the degree of stenosis.

**PULMONARY SYSTOLIC MURMURS**

A pulmonary systolic murmur may be due to pulmonary stenosis, to increased blood flow across the pulmonary valve or to dilatation of the main pulmonary artery. A pulmonary systolic murmur is probably the most frequent of all innocent murmurs.

*Pulmonary Stenosis*

As with aortic stenosis the characteristic murmur of pulmonary stenosis is loudest in mid-systole corresponding with the period of maximal ejection and as with aortic stenosis there is no close relationship between the intensity of the murmur and the degree of stenosis.

The murmur is usually accompanied by a systolic thrill and the intensity of the thrill corresponds with the loudness of the murmur.

In pulmonary stenosis the second heart sound may be finely split, widely split, faint or absent depending on the degree of stenosis.

#### *Increased Pulmonary Blood Flow*

A systolic murmur from increased blood flow across the pulmonary valve may be associated with any hyperkinetic state such as pregnancy, anaemia or thyrotoxicosis. It is often also heard in young persons especially on exercise.

In pathological states increased pulmonary flow may be associated with a left to right shunt e.g. with patency of the ductus arteriosus, an atrial septal defect or a ventricular septal defect.

#### *Parasternal Systolic Murmurs*

A systolic murmur which is loudest at the mid or lower left sternal border is usually due to tricuspid incompetence, congenital heart disease or is one of the innocent varieties.

#### *Tricuspid Incompetence*

Tricuspid incompetence may be due to organic deformity of the cusps from rheumatic endocarditis or to dilatation of the valve ring from cardiac failure. In severe cases systolic pulsation in the jugular veins and over the liver may be present. This murmur often increases in intensity during deep inspiration.

#### *Congenital Heart Disease*

The most usual cause is a ventricular septal defect. In such cases a corresponding systolic thrill is usually palpable.

#### *Innocent Murmurs*

This subject is discussed on page —

### APICAL SYSTOLIC MURMURS

A systolic murmur which is loudest at the apex always raises the possibility of mitral incompetence and is perhaps the most frequent source of uncertainty. If there is a past history of rheumatic fever, the murmur is heard out towards the left axilla, and if there is any radiographic evidence of left atrial enlargement this diagnosis must be made. Even if there is no other abnormality whatsoever it still cannot be denied that minimal rheumatic mitral disease may be developing and, if possible, the examination should be repeated a year later. However, the undesirability of making an error and diagnosing organic heart disease when none is present is far more important and of so much greater potential harm than mistaking a minor organic murmur that this slight risk may reasonably be taken. In the occasional instance even bacterial endocarditis may subsequently develop in mild rheumatic mitral disease but on balance there can be no question that this risk also should be accepted. *From the practical point of view minor mitral incompetence is of no dynamic significance and the patient should be reassured that the heart is healthy.*

### ISOLATED SYSTOLIC MURMURS

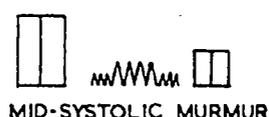
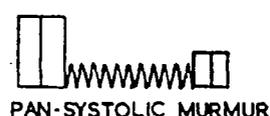
Isolated ('innocent,' 'incidental' or 'functional') systolic murmurs are of frequent occurrence in health and often pose a problem for the physician either because such a finding is made during the examination of a patient who has some condition unrelated to the heart or during the routine medical examination of school children, or of candidates for the armed forces, superannuation or life insurance.

When there is evidence of cardiac enlargement or when a diastolic murmur

is also heard, organic disease of the heart can be diagnosed with confidence but frequently no other abnormality is present. In such cases attention to detail, experience and commonsense are all important. The decision that a murmur is innocent depends not only on the absence of any evidence of organic heart disease but on the characteristics of the murmur itself.

The history is unlikely to be helpful in the type of case under consideration because symptoms related to the heart will not be present. If there is an unequivocal past history of rheumatic fever, more potential significance must be attached to a murmur but so often a history of possible rheumatic fever is inconclusive. Also a patient who has had rheumatic fever may have an innocent murmur and it is well known that some 40 per cent. of all those with unequivocal evidence of rheumatic heart disease give no history of rheumatic fever.

The characteristic features of the various organic conditions associated with a systolic murmur including valvular and congenital heart disease have already been described.



### HEART MURMURS

The physician must make quite sure that there is no clinical evidence of cardiac hypertrophy or enlargement, that there is no thrill, that the heart sounds and the pulses are normal and that no diastolic murmur is present. If there is any doubt about enlargement a radiograph should be taken.

Isolated systolic murmurs unassociated with any recognisable form of heart disease may be loudest at the apex, at the base or at the left sternal border.

In general it may be said that the louder the murmur the more likely is it to be of organic origin and few murmurs louder than Grade 2-3 are innocent. Also the harsher the murmur the more likely is it to be organic.

Innocent murmurs tend to be of relatively short duration and of high frequency but inevitably the dividing line from organic murmurs is not sharp. Also they tend to vary with respiration, posture and pressure of the stethoscope on the chest wall more than do organic murmurs.

#### Late Systolic Murmur

A particular variety of innocent murmur is one which develops in late systole shortly before the second heart sound, is loudest at the apex and may amount to Grade 3 or more in intensity.

This characteristic murmur is of maximal intensity at the apex and just

before the second sound. The first part of systole is silent. The murmur may be so loud and harsh that on this account it is often mistaken for organic heart disease. It is therefore all the more important to recognise. Unfortunately, as so often in medicine, there is no absolute rule and it is probable that a late systolic murmur may occasionally be associated with organic mitral incompetence, possibly with shortening of the chordae tendinae.

#### *Pulmonary area*

A pulmonary systolic murmur, loudest to the left of the upper sternum, is a frequent finding especially in young people and in pregnancy. Presumably it is due to blood flowing through the pulmonary valve but there is no evidence of valvular stenosis, dilatation of the pulmonary artery or any other abnormality.

#### *Parasternal*

These murmurs are usually of maximal intensity between the apex beat and the sternal border and may be faint or loud, fine or coarse but are of short duration and end about mid-systole. There will be no thrill or change in heart sounds.

### CLASSIFICATION OF DIASTOLIC MURMURS

#### EARLY

Aortic incompetence or Pulmonary incompetence.

#### MID

1. Mitral stenosis or Tricuspid stenosis
2. Increased flow

#### Mitral

Patent ductus arteriosus

Ventricular septal defect

#### Tricuspid

Atrial septal defect

#### LATE

Mitral or Tricuspid stenosis

### PRE-SYSTOLIC MURMURS

In patients with sinus rhythm a pre-systolic murmur may be due to stenosis of the mitral or tricuspid valves.

#### *Mitral Stenosis*

The classical physical signs of mitral stenosis are a loud slapping first heart sound preceded by a pre-systolic murmur, and an opening snap followed by a rumbling mid-diastolic murmur.

This cadence gives rise to the onomatopoeic "fftou ta ta rrou" first described by Duroziez.

The first or pre-systolic element of this sequence occurs late in ventricular diastole, synchronous with the forceful rapid passage of blood into the ventricle produced by atrial systole. It is therefore only heard in patients with sinus rhythm and disappears with the onset of atrial fibrillation.

This murmur is usually loudest at the apex and may be accompanied by a thrill.

An isolated pre-systolic murmur, that is without an associated mid-diastolic murmur, is only found in the early or mild stages of mitral stenosis.

#### *Tricuspid Stenosis*

A pre-systolic murmur similar in quality to that of mitral stenosis may be

heard in patients with tricuspid stenosis. This possibility should always be considered in patients with mitral valvular disease, especially if the pre-systolic murmur is well heard in the region of the sternum and is louder in deep inspiration which increases blood flow across the valve. In such cases there is likely to be a prominent 'a' wave in the jugular venous pulse.

Occasionally a pre-systolic murmur is heard in patients with aortic incompetence but without mitral stenosis and has been called the Austin Flint murmur after the man who first described it. The importance of this murmur has been exaggerated and its mechanism of production is still disputed. It will therefore not be discussed further.

### MID-DIASTOLIC MURMURS

A mid-diastolic murmur may be heard in mitral or tricuspid stenosis or in patients with increased blood flow across the valve without stenosis, i.e. with an intracardiac shunt.

The most characteristic sign of mitral stenosis is a long rumbling mid-diastolic murmur, loudest at or localised to the apex. If, as is so often the case, atrial fibrillation is present there will be no pre-systolic murmur but there may be a loud first heart sound and an opening snap as already discussed.

This murmur is best heard or may only be heard if the patient is lying down and turned towards the left side or if blood flow is increased by exercise. These manoeuvres, therefore, should be part of the routine examination of any patient suspected of having valvular heart disease.

It used to be thought that a mid-diastolic murmur at the apex was diagnostic of mitral stenosis but with the increased precision in auscultation which came with phonocardiography and in particular with the stimulus to careful auscultation brought by the advent of cardiac surgery, it has been recognised that a murmur similar in time but usually different in quality may occur in patients with congenital heart disease, associated with increased blood flow across the mitral valve.

### EARLY DIASTOLIC MURMURS

An early diastolic murmur, i.e. one beginning immediately after the second heart sound is characteristic of aortic or pulmonary valvular incompetence.

These two causes are not always easy to differentiate, the distinction, when possible, being made not from the qualities of the murmurs but from consideration of associated features.

#### *Aortic Incompetence*

This is usually loudest in the 3rd and 4th intercostal space close to the left sternal border. It may also be heard in the "aortic area" and, if loud, at the apex. When the murmur is audible at the apex it can usually be appreciated that there is no gap between the second heart sound and the beginning of the murmur, in contrast to the mid-diastolic murmur of mitral stenosis when there is a distinct gap and possibly an opening snap as discussed below.

The murmur is usually best heard with a diaphragm chest piece and with the patient sitting up or standing and with the breath held in expiration. It is well to remember these points if quiet murmurs are not to be overlooked.

The murmur of aortic incompetence is usually high pitched and blowing in quality. If harsh or musical and especially if heard best to the right rather than to the left of the sternum some cause other than rheumatic fever should be considered such as syphilis, bacterial endocarditis or trauma.

Although, in general, a loud murmur will be associated with severe incompetence there is no close correlation between these two features and many striking discrepancies. The severity of valvular incompetence and consequent regurgitation cannot in fact be assessed by auscultation but only by examination of the peripheral circulation and by seeking evidence of left ventricular hypertrophy. However, the signs of aortic incompetence are often modified by associated valvular stenosis.

With free regurgitation there will be a full, bounding "water hammer" or Corrigan pulse and a low diastolic blood pressure with a high systolic pressure and therefore a high pulse pressure. Exaggerated arterial pulsations may be obvious in the carotid and other arteries and capillary pulsation in the nail beds or retinal vessels. A "pistol" shot may be heard over a medium sized vessel such as the brachial or femoral artery if the vessel is lightly compressed with the bell of the stethoscope.

### *Pulmonary Incompetence*

As early diastolic murmur from pulmonary incompetence was first described by Graham Steele in a patient with severe pulmonary hypertension from mitral stenosis. This murmur is similar in quality to that of aortic incompetence and likewise will be audible down the left sternal border. It is impossible to distinguish the two by auscultation and the probability as to which valve is at fault must be decided by seeking signs of aortic regurgitation in the peripheral circulation on the one hand and of pulmonary hypertension on the other.

Pulmonary hypertension will be indicated by a loud second heart sound and clinical or electrocardiographic evidence for right ventricular hypertrophy. There will also be radiographic enlargement of the main pulmonary artery.

## CONTINUOUS MURMURS

The most frequently heard continuous murmur is that due to patency of the ductus arteriosus, a condition with which the student should be familiar. The murmur is that of an arterio-venous fistula but the differential diagnosis will not be discussed being the province of the specialist.

\* \* \* \*

In the first part of this paper it was suggested that the recently introduced Leathan modification of the Bowles stethoscope was probably best. Further experience has shown that this model has certain defects and the student is therefore advised to use the standard bell and diaphragm chest piece manufactured by Messrs. Thackray of Leeds.