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Auscultation of the Heart I

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Abstract
"And the babe leaps up on his mother's arm I hear, I hear, with joy I hear."
Wordsworth.

All students find initial difficulty with auscultation and to some, variations in heart sounds and murmurs remain a mystery. However, given normal hearing, a good stethoscope, an appreciation of underlying mechanisms and reasonable opportunity to practise, everyone would become sufficiently competent. The essential requirements are a methodical approach and attention to detail and then, if what is heard is accurately recorded, the correct diagnosis should follow in most cases. It is important to be able to recognise variations in the intensity and splitting of the heart sounds, the physiological and pathological forms of triple rhythm and the murmurs associated with valvular stenosis or incompetence and with congenital cardiac and vascular defects. Recognition of auscultatory phenomena is important not only for accurate diagnosis but to avoid errors of interpretation and, in particular, the frequent error of suspecting or actually diagnosing heart disease when none is present and thereby engendering anxiety and imposing unwarranted restrictions.

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AUSCULTATION OF THE HEART
I

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All students find initial difficulty with auscultation and to some, variations in heart sounds and murmurs remain a mystery. However, given normal hearing, a good stethoscope, an appreciation of underlying mechanisms and reasonable opportunity to practise, everyone would become sufficiently competent. The essential requirements are a methodical approach and attention to detail and then, if what is heard is accurately recorded, the correct diagnosis should follow in most cases.

It is important to be able to recognise variations in the intensity and splitting of the heart sounds, the physiological and pathological forms of triple rhythm and the murmurs associated with valvular stenosis or incompetence and with congenital cardiac and vascular defects.

Recognition of auscultatory phenomena is important not only for accurate diagnosis but to avoid errors of interpretation and, in particular, the frequent error of suspecting or actually diagnosing heart disease when none is present and thereby engendering anxiety and imposing unwarranted restrictions.

Undergraduates, of course, find difficulty from lack of experience. However, difficulty is often largely due to lack of a good technique and to lack of appreciation that there is a rational and usually simple explanation for all that can be heard.

Postgraduate students are often more familiar with what they have been told or read than with bedside observation and tend to find physical signs which they consider ought to be present rather than to record what can actually be heard.

More senior physicians often find difficulty because they were trained before the days of modern precision which is due to the more accurate analysis made possible by phonocardiographic studies and the stimulus to accuracy provided by cardiac surgery and the special techniques employed to establish pre-operative diagnosis.

Sometimes undue attention is given by specialists to what might be termed the minutiæ of auscultation which is more often an academic study than of practical value, because so often at the bedside there is a difference of opinion over details even between practised observers. On such occasions phonocardiography is as indispensable to auscultation as electrocardiography is to the interpretation of arrhythmias, but most often it is used as a research technique. Theoretical concepts are not always fulfilled in practise.

Stethoscope

It is surprising to find that some students still possess a stethocope with only a bell chest piece. Anyone having doubts as to the value of a diaphragm will soon have them removed by comparing the relative intensity of a high pitched murmur with both types of chest piece. The best example is the

familiar early diastolic murmur of aortic incompetence. Such a murmur is always better heard with a diaphragm and if faint may not be audible at all with a bell. Similarly the low pitched rumbling mid-diastolic apical murmur which is characteristic of mitral stenosis is more readily heard with a bell and may be missed altogether with a diaphragm.

Probably the best stethoscope is Leatham's modification of the Sprague-Bowles variety. By means of a small lever one can switch conveniently from bell to diaphragm without detaching the end piece. The bell is designed to accentuate lower frequencies by filtering out the higher frequencies and the diaphragm responds best to higher frequencies. The length of tubing is also important, the shorter the better . A length of 10-12 inches is suitable, with an internal diameter of ⅛th inch. Ear pieces should fit snugly so that the best size will vary between individuals.

One further point as regards the use of the stethoscope may be mentioned and that is that variation in the pressure with which the end piece is applied to the chest wall makes a considerable difference to the ease with which different sounds and murmurs may be heard.

There is no mystery about these findings which are based on simple physical principles.

The practise of medicine is sufficiently complex without adding difficulties by inadequate equipment and the small extra financial outlay will pay good dividends over the years.

Technique

Practise tends to make perfect but everyone will agree that all the practise in the world will not necessarily make a good musician or golfer or physician. Nevertheless skill in auscultation does come with practise and every beginnner will be surprised at how much can be heard once something has been pointed out and once the lesson has been learned of listening methodically to one thing at a time.

It is best to begin by concentrating on heart sounds in each of the four conventional "areas." The first heart sound is best heard at the apex (mitral area) and at the lower left sternal border (tricuspid area). The second heart sound is best heard at the base to the right of the upper sternum (aortic area) and to the left of the upper sternum (pulmonary area).

Then, forgetting about heart sounds, attention should be paid to murmurs first in systole, that is between the first and second sounds. It is a good plan, having detected the presence of a murmur and its position of maximum intensity, gradually to "edge" the stethoscope out in each direction to note its "propagation" or "conduction." In some circumstances this procedure greatly facilitates diagnosis. For example, if a systolic murmur is loudest at the mid or lower left sternal border and can be traced to the aortic area it is almost certainly due to aortic stenosis. If an apical systolic murmur is conducted to the axilla or beyond to the left lung base it almost certainly derives from mitral incompetence.

In general, of course, a murmur is "conducted" in proportion to its intensity.

The Discipline of Auscultation

"And sanctifying by such discipline
Both pain and fear—until we recognise
A grandeur in the beatings of the heart."

Wordsworth.

Are both heart sounds present, and if so, is each normal? If not, is

the first sound louder or weaker than normal (or absent) or split? Is the second sound louder or weaker (or absent) or split? Are there more than two heart sounds? If so, is the extra sound in systole or in diastole?; and nearer the first or the second sound?; and what is its quality? Is it preceded or followed by a murmur?

If a murmur is heard there should follow a similar mental catechism. Over what area is it audible and where is it loudest? In which direction is it next loudest (or "conducted") and how far from the position of maximal intensity can it be heard? What are its time relationships to the heart sounds? Is it systolic or diastolic? If systolic does it occur in early, mid or late systole or is it pan-systolic? If diastolic is it early, i.e. immediately following the second heart sound, or mid, i.e. after an appreciable gap from the second sound, or late., i.e. pre-systolic? As will become clear when dealing with individual defects and diseases each of these features has a particular significance in diagnosis.

Some attempts at grading the intensity and describing the qualities of a murmur should always be made. It does not matter how many grades are used by different observers so long as the standard is stated. This can easily be expressed as a fraction. If, for example, a systolic murmur is recorded as Grade 3/5 intensity this signifies that the maximum number of grades recognised by the observer is 5—the faintest being Grade 1 and the loudest likely to be heard is Grade 5 so that the murmur in question is a moderately but not very loud one. The three grades faint, moderately loud and very loud sometimes used are not really sufficient if changes from time to time are to be recorded.

As regards quality it would be helpful if agreement could be reached over adjectives, and preferably their number should be restricted.

It is suggested that it would be sufficient to use the term blowing, harsh or rumbling and high or low pitched with a few additions for unusual murmurs such as whistling, musical or raucous.

Phonocardiography

Phonocardiography is the graphic registration of heart sounds and murmurs. A piezo-electric microphone is placed on the chest wall and the vibrations produced by the heart are picked up, transmitted, filtered, amplified and recorded.

The crystal has the property of converting sounds or pressure waves into electric currents and responds fairly uniformly over the range of frequencies required in phonocardiography.

Phonocardiography has brought precision to auscultation and having laid the basis for the correct appreciation of auscultatory findings is now rarely necessary in practise. It is principally useful in cases of dispute for teaching and research and in special cases where permanent or serial records are required.

Phonocardiography is no substitute for auscultation.

Genesis of Heart Sounds and Murmurs

It is generally assumed that heart sounds are due to vibrations set up by abrupt changes in the velocity of the blood stream. Valve closure suddenly arrests or reverses the movement of blood and plays a major role in the genesis of the normal heart sounds.

Murmurs are thought largely to result from turbulence in a rapidly flowing stream of blood.

From the clinical aspect heart sounds appear very short, but from the

phonocardiographic point of view there is no clear dividing line between sounds and murmurs which are mainly distinguished by duration.

Heart Sounds

The first heart sound is mainly produced by closure of the mitral and tricuspid valves when the ventricular pressures rise above that of the atria.

The second heart sound is due to closure of the aortic and pulmonary valves when ventricular pressures fall below that in the great vessels.

Normally mitral and aortic valve closure are louder than tricuspid and pulmonary valve closure and this in part may be related to the greater pressures on the left side of the heart.

Both heart sounds may be difficult to hear on account of:

1. Thickness of the chest wall.
2. Increased antero-posterior diameter.
3. Emphysema.
4. Pericardial effusion.
5. Decreased force of cardiac contraction.

Qualities of the Heart Sound

The following properties should be noted.

1. Increased intensity.
2. Decreased intensity or absence.
3. Varying intensity.

Intensity of the First Heart Sound

The intensity of the first heart sound is mainly dependent on the position of the valve leaflets at the onset of ventricular systole, and on the force of ventricular contraction. If the valve is wide open and the cusps are far apart and have a relatively long way to go in order to shut, the closing sound will be relatively loud but if they are close together it will be relatively faint. The cusps will tend to be far apart if ventricular filling is prolonged, e.g., from valvular stenosis or increased blood flow or if the A-V conduction time is short.

The first heart sound tends to be **loud** with tachycardia from any cause such as exercise, emotion, fever or anæmia, and in other hyperdynamic circulatory states such as thyrotoxicosis.

In mitral stenosis the first heart sound is characteristically loud and "slapping." This in part is due to prolongation of atrial systole with the result that the valve leaflets are deep in the ventricle at the onset of ventricular systole, partly to the shortened chordae tendiniae holding the leaflets back and in part to the fact that the cusps are thickened as a result of rheumatic endocarditis.

By contrast a relatively quiet first sound (when not due to such factors as a thick chest wall, emphysema or pericardial effusion) may be due to prolongation of diastole so that the cusps have had time, so to speak, to float together, and consequently make little sound by their apposition. This will occur with bradycardia. In mitral incompetence either the leaflets will not come together at all from structural defect or from widening of the valve ring or they will do so imperfectly and as a result the first sound will be absent or weak.

Similarly, **variation in intensity** of the first sound will be present if there is dissociation between atrial and ventricular contraction such as may result from complete heart block, atrial flutter or ventricular tachycardia when the atria and ventricles beat at different rates.

It will be appreciated that the intensity of the first heart sound bears an inverse ratio to the atrio-ventricular conduction time as reflected in the P-R interval of the electrocardiogram, that is, the shorter P-R interval the louder the sound.

Intensity of the Second Heart Sound

Increased intensity of the second sound at the base of the heart may be due to systemic or pulmonary hypertension. Actually the relationship is not a direct one and there are usually other factors operative which influence the intensity. Thus the aortic second sound is by no means always loud even in severe systemic hypertension, loudness being much more often associated with atheroma and in some cases of severe pulmonary hypertension from mitral stenosis the pulmonary second sound may not be loud, possibly from decreased blood flow.

Since the second heart sound is due to closure of the semi-lunar valves, **decreased intensity** or absence of the sound will result from deficient closure. Thus the aortic second sound may be weak or absent from aortic stenosis or incompetence and in such cases the second sound in the pulmonary area (which is often finely split since closure of both valves can be heard here) will be single. If the pulmonary second sound is loud (from pulmonary hypertension) in such cases of aortic valvular disease, this will be heard to the right of the sternum. The pulmonary second sound may be weak or absent from pulmonary stenosis. Since pulmonary incompetence is almost always due to severe pulmonary hypertension the second sound in such cases is loud.

Physiological Third and Fourth Heart Sounds

A third heart sound early in diastole, that is shortly after the second heart sound, can often be heard in young people.

A fourth heart sound late in diastole (pre-systole), that is just before the first heart sound, can usually be recorded by phonocardiography but is rarely audible. These two physiological sounds are described later in the section on triple rhythm.

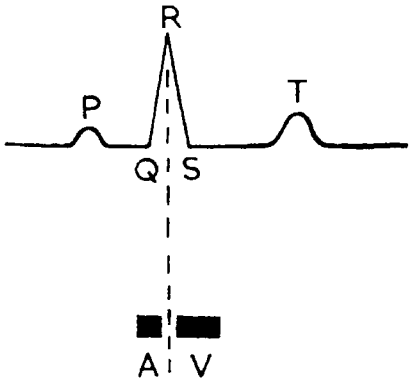
Splitting of the First Heart Sound

The first heart sound is not a pure harmonic vibration but is composed of a number of unrelated frequencies. Normally four components can be recorded but only two are heard. The first component may be due to atrial vibrations, as usually described, or be of muscular origin, as more recently suggested. The second and third components may be heard separately or as one sound and coincide with isometric contraction of the left and right ventricles respectively. It is now generally agreed that these sounds are due to closure of the mitral and tricuspid valves. The last or fourth component is probably due to systolic ejection of blood and may be vascular or valvular in origin.

Physiological splitting of the first heart sound is due to slight asynchrony in ventricular contraction and therefore in mitral and tricuspid valve closure, and is a normal phenomenon.

This can often be appreciated in healthy subjects by listening at the lower end of the sternum, which is the position where the stethoscope is nearest to the relatively quiet tricuspid component, and paying particular attention to expiration when there is relatively little lung tissue between the heart and chest wall.

The importance of a split first sound lies in its recognition and in differentiation from other conditions.



1st. HEART SOUND

A = ATRIAL COMPONENT

V = VENTRICULAR "

Fig. 1

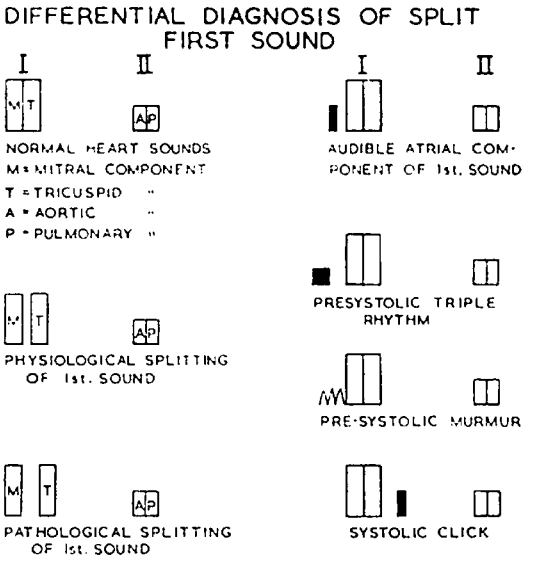


Fig. 2

Pathological splitting occurs in complete right bundle branch block when impaired conduction results in delay in tricuspid valve closure and hence in wide splitting of the heart sounds.

DIFFERENTIAL DIAGNOSIS OF SPLIT FIRST SOUND

Atrial Component of First Heart Sound

The atrial component of the first heart sound cannot usually be differentiated by ear, but in cases of partial heart block in which prolongation of the P-R interval reflects delay in A-V conduction this component may be heard and splitting of the first sound may be simulated.

Pre-systolic Triple Rhythm

Splitting of the first heart sound must also be distinguished from pre-systolic triple rhythm as discussed below. In splitting the two components are very close together and of somewhat similar quality, and in triple rhythm, the extra sound precedes the first heart sound by an appreciable distance and is of a different, lower pitched quality.

Pre-systolic Murmur

In mitral stenosis atrial systole results in a pre-systolic murmur at the apex. This murmur becomes louder when blood flow is increased by exercise or tachycardia from any cause. Most often such a murmur is associated with a loud first sound ("closing snap"), an "opening snap" and a mid-diastolic murmur, but in patients with mild stenosis only a slight pre-systolic murmur may be present, and in such cases there may be difficulty in differentiation from splitting of the first heart sound.

Systolic "Click"

Apparent splitting of the first heart sound may be due to the addition of an added sound or "click," synchronous with ventricular systole and due to vibrations in a dilated ascending aorta or main pulmonary artery.

In such cases the added sound is usually heard at the base of the heart in the aortic or pulmonary areas and occurs immediately after the second heart sound.

Splitting of the Second Heart Sound

PHYSIOLOGICAL SPLITTING

Physiological splitting of the second heart sound is due to slight asynchronous closure of the aortic and pulmonary valves.

During inspiration the normally negative intra-thoracic pressure becomes still more negative with resultant increase in the venous return to the right side of the heart. With deep inspiration this is exaggerated with resultant prolongation of right ventricular systole and delay in pulmonary valve closure. Consequently the second heart sound in the pulmonary area becomes more widely split and this can often be recognised in healthy people.

It can be shown by phonocardiography that the single second sound which can normally be heard in the aortic and mitral areas and also the first component of the normally split second sound in the pulmonary area is due to aortic valve closure. The second component in the pulmonary area is due to pulmonary valve closure.

PATHOLOGICAL SPLITTING

Abnormal splitting of the second heart sound is most often due to delay in pulmonary valve closure but rarely may also result from premature closure of the aortic valve.

Delay in pulmonary valve closure may result from delayed activation of the right ventricle or to prolongation of right ventricular systole. Activation of the right ventricle is delayed in right bundle branch block.

Prolongation of right ventricular systole may result from a relative increase in right stroke volume compared with the left such as occurs from a left to right intra-cardiac shunt through an atrial septal defect or from obstruction to ouflow such as occurs with pulmonary stenosis. In such cases splitting cannot be further increased by deep inspiration and is usually described as being "fixed."

Early aortic valve closure may result from the decreased resistance to left ventricle outflow which occurs in incompetence of the mitral valve.

Splitting of the second heart sound must be differentiated from triple rhythm and from the opening snap of the mitral valve. In the latter instance there will also be present a mid-diastolic murmur. A mid-diastolic murmur may also occur without a preceding snap and if short may also cause difficulty in diagnosis.

(TO BE CONTINUED)

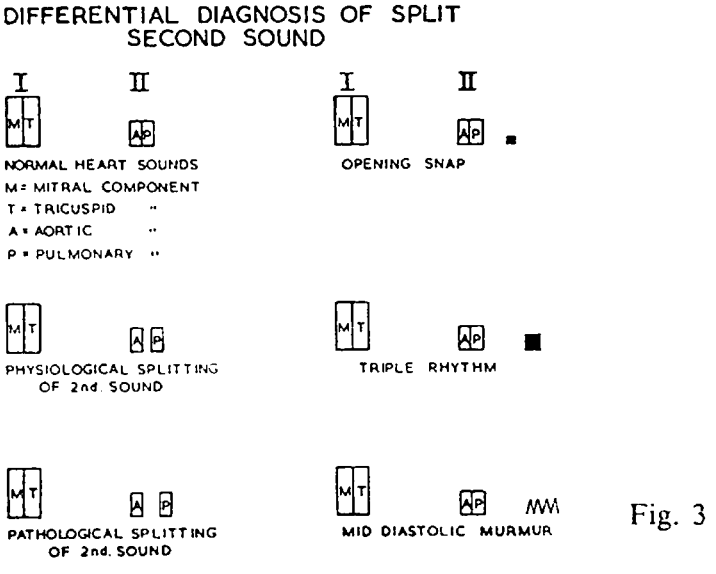


Fig. 3