

murmur being even rarer than the systolic, and as aortic murmurs are frequently heard with great distinctness in the same region, the actual existence of a genuine tricuspid murmur can be affirmed only when the consecutive signs of aortic lesion are obviously wanting and those of tricuspid lesion (more particularly the venous pulse) are demonstrably present.

#### 4. PULMONARY MURMURS.

Murmurs emanating from the pulmonary artery are of extreme rarity; when they occur they are most plainly audible in the second left intercostal space, close to the sternal insertion of the third rib, that is, exactly at the part beneath which the pulmonary orifice is situated.

The different heart-murmurs may be associated with each other in various ways. The commonest instance of this is seen in the combination of two murmurs, a systolic and a diastolic, at the same spot; this takes place most often at the mitral valve, next most frequently at the aortic orifice.—The other variety of combination is that in which murmurs arise at two or even more separate points within the heart. The fact that such murmurs originate independently of each other in any given case is placed beyond doubt by observing that they are of nearly equal intensity, and are possibly very dissimilar in timbre, at two different points on the surface. If the murmur be simply systolic at one of these and exclusively diastolic at another, it is self-evident that it is double, owing its existence to morbid alterations at more than one part of the heart. But even when two systolic or two diastolic murmurs present themselves at two points in the præcordial region the recognition of their separate origin is as a rule very easy. As tricuspid and pulmonary lesions are on the whole somewhat uncommon, the murmurs which are most often combined are those proceeding from the mitral and aortic valves.

The occurrence of two murmurs, at two of the valves or two of the orifices of the heart, does not affect their propagation or the localization of their points of greatest intensity. Thus if there be a systolic murmur at the mitral valve and a diastolic murmur at the aortic valves, the former, as already indicated, continues loudest at the apex, the latter at the sternal insertion of the third right rib or over the surface

of the breast-bone.—The number of murmurs heard in the præcordial region varies with the number of valves or cardiac orifices involved in disease. At each auriculo-ventricular valve and orifice two murmurs may be generated, one, systolic in rhythm, when the valve is incompetent, one, diastolic, when the orifice is contracted; and similarly, at the root of each of the great arteries two murmurs may originate, one, systolic, when the arterial orifice is narrowed, and one, diastolic, when the valves which guard the orifice become insufficient. It is to this that the great variety of combination into which murmurs enter in complicated cardiac diseases is due. I had for a long period one case under observation, in which five different murmurs were distinguishable, one systolic and one diastolic at each of the arterial orifices and one systolic at the mitral valve.

Occasionally the differentiation, particularly as regards timbre and seat of greatest intensity, of the various murmurs dependent on cardiac diseases of a complex nature, is attended by some little difficulty, on account of the influence which these morbid sounds exert on each other in being propagated through the tissues; as a rule, however, a consideration of the other physical signs and the consecutive changes in the heart, as well as of the condition of the circulation generally, is sufficient to guide one to a safe conclusion with reference to the point at which a murmur is produced.

The following is a résumé of the physical signs connected with the various heart murmurs.

#### 1. MITRAL INSUFFICIENCY.

*A systolic murmur presenting its greatest intensity at the apex of the heart (the systolic sound being either completely wanting or still heard with greater or less distinctness), hypertrophy and dilatation of the right ventricle, and intensification of the second pulmonary arterial sound.*

#### 2. MITRAL STENOSIS.

*A diastolic or presystolic murmur loudest at the apex (sometimes also, when the heart's action is tranquil, reduplication of the diastolic sound), hypertrophy and dilatation of the right ventricle and intensification of the second pulmonary arterial sound.—When, as is very frequently the case, there is mitral insufficiency as well as stenosis present, the diastolic murmur is combined with one which is systolic in rhythm.*

#### 3. TRICUSPID INSUFFICIENCY.

*A systolic murmur most distinct over the lower part of the sternum, systolic pulsation of the jugular veins, and sometimes very marked enfeeblement of the second pulmonary arterial sound (from lowering of the blood-pressure within that vessel).*



## 4. TRICUSPID STENOSIS.

This is an extremely rare cardiac lesion, scarcely ever occurring alone. It is marked by a diastolic or presystolic murmur, loudest over the lower part of the sternum, and by presystolic pulsation of the jugular veins.

## 5. STENOSIS OF THE AORTIC ORIFICE.

A systolic murmur most audible in the second right intercostal space at the sternal insertion of the third right rib, of equal intensity over the whole of the upper part of the sternum (the first sound being absent or still heard along with the murmur), hypertrophy and dilatation of the left ventricle, a very small radial pulse. This affection is generally complicated by insufficiency of the aortic valves, when the signs proper to the latter are added to the foregoing.

## 6. AORTIC INSUFFICIENCY.

A diastolic murmur of maximum intensity over the greater part of the sternum and in the second right intercostal space at the sternal insertion of the third rib; the first aortic sound is often muffled, or superseded by a murmur, as the entrance to the vessel is usually roughened by structural change or deposit, and is therefore the seat of more or less considerable narrowing. In the carotid artery the first sound is commonly of a similar, indistinct character, or is replaced by a murmur, the second carotid sound being absolutely wanting or masked by the diastolic murmur transmitted from the aorta. This lesion is further characterised by hypertrophy and dilatation of the left ventricle, and a bounding pulse. The arterial pulse may be accompanied by an audible sound.

## 7. STENOSIS OF THE PULMONARY ARTERIAL ORIFICE.

A systolic murmur most marked in the second left intercostal space close to the sternum; hypertrophy and dilatation of the right ventricle.

## 8. INSUFFICIENCY OF THE PULMONARY ARTERIAL VALVES.

A diastolic murmur whose seat of maximum intensity is in the second left intercostal space; hypertrophy and dilatation of the right ventricle.—Pulmonary arterial lesions are very seldom met with; when they do occur both forms, stenosis and insufficiency, are most commonly combined.

## AORTIC ANEURISMS.

These sometimes give rise merely to systolic murmurs, or, if complicated by insufficiency of the valves, also to diastolic murmurs, the systolic sound being still audible or entirely abolished.

The point of maximum intensity of aortic aneurismal murmurs generally coincides with that of murmurs due to aortic stenosis or insufficiency, the propagation and distribution of such murmurs, however, varying with the size and the precise situation of the tumour. Thus, the murmur from an aneurism of the ascending portion of the arch of the aorta is heard most clearly in the second right intercostal space and over the sternum, that from aneurism of the transverse part of the arch passing still further to the left of the sternum. All these murmurs are frequently perceptible to palpation over a large extent of surface. They may, however, be entirely wanting even in aneurisms of moderate size, provided that the aortic orifice be not contracted by very rough growths and that the sigmoid valves be still intact; in such circumstances simple heart-sounds of greater or less purity take the place of murmurs. Aneurisms of the aorta lead to hypertrophy of the left ventricle when, as is usually the case, the aortic valves are at the same time insufficient; but should the latter structures continue capable of effecting complete closure of the orifice the ventricle may show no increase in size.

## PERICARDIAL MURMURS.

So long as the opposed visceral and parietal surfaces of the pericardium retain their normal perfect smoothness, the gliding of the one upon the other, which necessarily takes place when the heart contracts and moves about in the pericardial sac, is accomplished absolutely noiselessly. But when they are roughened by the deposit of fibrinous exudation, as the result of inflammation of the pericardium, the friction of the one on the other, due to the heart's movements, gives rise to certain murmurs, known as *pericardial friction-murmurs*.

The impression these sounds make on the ear is that of a light rubbing, scratching, grating, &c., characters which alone are generally sufficient to distinguish them from the soft blowing murmurs of endocardial origin.

Pericardial friction-murmurs also, those at least arising on the front of the heart, are very frequently accompanied by well-marked *fremitus* which, except that it is somewhat feebler, is in no way different from the thrill due to pleuritic friction. The general character of this vibration is such as to suggest a very superficial origin,—it seems to proceed from a point immediately beneath the chest-wall; as there is no palpable *endocardial* murmur which bears any resemblance to the palpable *pericardial* murmur in this particular respect, attention to this sign alone is enough to set at rest any doubt as to the origin of a murmur.



Next in diagnostic importance to this superficial quality is another by which pericardial may be known from endocardial murmurs: *they are not permanently synchronous with the systole or diastole, but are apt to occur irregularly in the cardiac cycle, following at one time the systole, at another the diastole, according to the situation of the points, on the surface of the heart, at which the roughened pericardial membranes come into contact.* Thus, a friction-sound may be heard at the base of the heart an instant earlier than in the region of the apex, as the contraction of the auricles precedes the ventricular systole.—Most commonly both of the heart-sounds remain audible, the friction-murmur being interposed between them. Pericardial murmurs, also, are never propagated to such a distance as endocardial murmurs; sometimes at parts comparatively close to those at which they are distinctly appreciable they become feeble or even disappear completely.

The *intensity* of pericardial murmurs depends principally on the following conditions: the amount and thickness of the fibrinous deposit, the degree of energy with which the heart acts, the locality at which the murmurs are generated (other things being equal, therefore, friction-sounds developed towards the front of the pericardium are louder than the others), and the attitude of the patient. Friction-murmurs may be caused to disappear from one part and reappear at another by changing the attitude of the patient and so altering the position of the heart, the visceral and parietal surfaces of the investing membrane being then brought to bear on each other at different points. In the same way they may be weakened or even abolished by placing the patient on his back, or, on the other hand, they may be first called into existence, or intensified, when he is caused to sit or stand or to turn over to the left side. Inspiration, when it coincides with the contraction of the heart, has usually the effect of increasing the intensity of the friction-murmur.

The various conditions which have been described above as diminishing or increasing the intensity of pericardial murmurs have no such influence on endocardial murmurs; a consideration of these diagnostic indications, therefore, apart from the other signs of pericarditis, usually enables one to recognise with certainty the pericardial nature of a murmur, even when the latter presents a low degree of intensity.

It is only very soft and feeble pericardial murmurs, such as communicate no feeling of vibration to the hand and thus want one of their most characteristic features, that are apt to be mistaken for those of endocardial origin; this happens particularly when the heart acts irregularly and with great rapidity, when there is almost no possibility of making a distinction between systole and diastole. But even in such cases prolonged observation, and examination when the heart's action is quiet, generally warrant the formation of a positive diagnosis.—No reliance is to be placed on the rule sometimes laid down, that simple pressure with the stethoscope, which brings the two pericardial surfaces into more intimate contact with each other, serves to distinguish between pericardial and endocardial murmurs by intensifying the former and weakening the latter, as murmurs really taking their rise within the heart are sometimes rendered louder by this manoeuvre,—occasionally even a pure systolic heart-sound at the apex may, by exercising pressure in this way, be transformed into a well-marked systolic murmur.

Sometimes friction-sounds which differ from each other in some particular, but which nevertheless are of equal intensity, are heard at several points in the præcordial region; such murmurs are not produced at and transmitted from one common point of origin, but proceed from several distinct and separate spots on the heart's surface.

Friction-sounds are not usually audible throughout the whole period that the pericarditis lasts, but, as a rule, only at its beginning and end,—at the outset of the disease, as the amount of exudation poured out is still comparatively small and the two layers of the pericardium are thus permitted to come into closer relation to each other, and towards its termination, as the fluid portion of the exudation is now absorbed and only the firm fibrinous portion is left behind; but at that stage of the affection at which the exudation is most abundant the murmur disappears, the serous surfaces being held apart by the mass of fluid interposed between them. Pericardial and pleuritic friction are thus subject to exactly the same laws as regards the particular stage of the disease at which they are observed.—Pericardial friction appears earliest and most frequently at the *base of the heart*, in the neighbourhood of the great vessels, as at this part the organ is less freely movable than in its lower segment, and the pericardial surfaces are allowed to remain longer in contact; here also a much more copious exudation of fluid is required to separate the visceral from the parietal layer of the pericardium and



so prevent them from rubbing on each other. On the other hand, friction-sounds often persist for weeks after the subsidence of the pericarditis, but they diminish gradually in intensity as the fibrinous deposit melts and becomes more fluid, till they disappear altogether when the surfaces regain nearly their normal smoothness or when the two portions of the membrane are glued together by adhesions.

Pericardial friction-murmurs are not dependent solely on pericarditis; they are sometimes due to tuberculosis or cancer, ecchymoses or callous thickening, of the pericardium, muscular tumours of the heart, and similar affections. It is stated also that abnormal dryness of the pericardium, in the stage of asphyxia in cholera, occasions pericardial murmurs; for my part I have never observed murmurs of this nature, though I have frequently searched for them in patients in the condition described.

Murmurs are also sometimes caused by the presence of roughness of the *outer* surface of the pericardium, when this part of the membrane rubs against the adjoining portion of the lungs or the thoracic parietes; these are termed *extrapericardial* or *pneumo-pericardial* murmurs, and are identical in character with the *intrapericardial* murmurs.—Finally, the pericardium may be perfectly smooth but may move to and fro on the roughened pleura (in cases of Pleurisy). Murmurs (*pleuro-pericardial*) so produced are usually enfeebled or even abolished by simply holding the breath; very rarely they persist notwithstanding that respiration is suspended. The formation of a diagnosis between *intra-* and *extrapericardial* murmurs is possible only on taking into full consideration all the other signs furnished by physical examination, though even then it cannot always be made with perfect certainty.

## AUSCULTATION OF THE ARTERIES AND VEINS.

### ARTERIAL SOUNDS.

As in the initial portion of the aorta, so in the great vessels springing from it, certain sounds are heard accompanying each contraction of the heart, developed partly in these arteries themselves, but for the most part conducted thither from the aorta. The only arteries which it is customary to auscultate for the purpose of investigating these sounds, are the carotid and subclavian; in certain cases, however, to be mentioned further on, vessels of much smaller calibre, such as the brachial or femoral, are examined with the same end in view. The point at which the carotid may best be auscultated is in the fossa inter-sternocleidomastoidea, that best adapted for the study of the subclavian sounds being in the supra- or infraclavicular fossa, towards the acromial end of the collar-bone.

If the stethoscope be placed lightly on the carotid artery, when the circulatory apparatus is in its normal state, there are heard *two* perfectly pure sounds accompanying each cardiac systole, separated from each other by a short pause; the first of these coincides with the expansion, the second with the contraction of the artery. The expansion of the carotid artery is synchronous with the systole of the heart, its contraction is simultaneous with the cardiac diastole.

To prevent misunderstanding I think it is better to avoid the use of the terms "systole" and "diastole" in describing the periods in which sounds and murmurs are heard in the arteries, as those words have become so intimately associated with the nomenclature of the phases of the heart's action that they at once and involuntarily recall the latter to mind; all risk of confusion in this matter may be obviated by employing the terms "contraction" and "expansion" with reference to the arteries.—It is only in large arteries, those situated close to the heart, that arterial expansion, *i.e.*, the arterial pulse, corresponds exactly with the heart's systole; in the more remote vessels the interval between the cardiac pulsation and the arterial throb may be so prolonged that the latter comes to coincide almost with the diastole of the heart or occurs