

26th, and half a glass was given in water every three hours till the 28th, when the pulse began to fall to 124. The patient made a slow but perfect recovery, being confined to bed until the 15th May, by which time she was able to sit up a little every day. Desquamation of the cuticle commenced on the 6th May. There was no dropsical effusion, and never any secretion of milk. She did not menstruate for three months after her recovery.



ARTICLE X.—*Clinical Lectures on Diseases of the Heart.* By GEORGE W. BALFOUR, M.D., F.R.C.P., Physician to the Royal Infirmary, Edinburgh.

I.—*On the Murmurs and other Physical Signs Distinctive of Mitral Stenosis.*

GENTLEMEN,—Were I to ask you to tell me what sign you suppose to be most distinctive of disease of the mitral valves, probably nine out of every ten would, without hesitation, reply, A systolic murmur loudest at the apex. Yet this, though the belief of a large proportion of medical men, is far from being the truth. A systolic apex murmur is by no means always a certain proof of any positive derangement of the cardiac mechanism. Such a murmur may, as you are aware, be of exocardiac origin, and the valves may in this case remain healthy, and their action perfect, in spite of the persistence of a murmur having the character described. It is even said that a murmur of this kind may be of endocardiac origin, and yet the valvular mechanism remain uninjured; and though such an occurrence must happen but rarely, still it is a possibility which we must never forget in estimating the probabilities in favour of our diagnosis. But systolic apex murmurs originating exocardially, or even endocardially, apart from valvular derangement, are not of course associated with regurgitation backwards into the auricle, and are free from any of the signs and symptoms dependent on that accident; yet, even though regurgitation be unequivocally proved to exist along with a systolic apex bruit, mitral disease or deformity is not therefore a necessary consequent, because both do occur in a not inconsiderable proportion of cases in which the mitral valve is nevertheless perfectly healthy. In fact, the mitral valve may be free from disease, and the auriculo-ventricular opening perfectly natural and undilated, and yet regurgitation may, and often does, take place. How this may be I shall take another opportunity of explaining; it is sufficient for the present to state the fact that, even where mitral regurgitation is clearly established, it is no positive proof of disease of the mitral valve; and I shall presently describe those signs which must coexist to prove this regurgitation to be certainly dependent upon disease of the valves. On the other hand, there is a murmur which is so invariably associated with disease of the mitral valve that, when once heard, it

may be conclusively accepted as a distinctive proof of the existence of a permanent deformity, even though the murmur itself should subsequently disappear, as it frequently does. This murmur, which is pathognomonic of mitral stenosis, has been termed, *par excellence*, the presystolic murmur. It is well, however, to remember that this is a misnomer. As the term is, however, a convenient one, and has been long attached to this special murmur, it is perhaps right to continue its use, provided always we recollect that it is merely conventional, and not strictly accurate.

The history of the presystolic murmur commences with M. Fauvel, who, in 1843, not only described its characteristics, and amongst them its rhythm, but actually gave it the name by which it is still best known. British physicians are, however, mainly indebted for a clear understanding of this important murmur to the writings of Dr Gairdner, whose lucid statements and admirable diagrammatic representations were first published in 1861. In Edinburgh this murmur is of such frequent occurrence, so generally recognised, and the recognition verified every session by the discovery of the predicted pathological condition, that it is simply incomprehensible how its existence is still ignored by some even of the most esteemed members of our profession. Not, perhaps, that it is altogether ignored, though that sometimes happens—but its true character is denied, which is perhaps worse.

In estimating the nature of any murmur supposed to be of valvular origin, you are aware that it is absolutely necessary to be precise in ascertaining two facts regarding it: the first being the position on the cardiac area at which it is most distinctly heard, and the second its rhythm; that is, its proper relation to the several acts which constitute a cardiac pulsation. These points being determined, the ascertaining of the lesion upon which the murmur depends is a simple matter of ratiocination, in which it seems hardly possible to err. Now, the murmur I speak of has a fixed position in which it is most distinctly heard—viz., over what has been already described to you as the mitral area; that is, within a circle of about an inch, described round the point where the apex impinges as a centre. It is not much propagated in any direction, and though the educated and experienced ear can readily detect the alteration of the first sound produced by the presence of this murmur, wherever the heart-sounds can be heard, yet it is only over a very limited area that it is audible as a true murmur, being comparatively rarely to be heard above the third rib, while its distinct propagation is, as a rule, almost equally limited in every other direction. To give you some idea of this limitation of propagation, I may mention that there is now in the wards a lad of eighteen with a murmur of this character, so loud and rough that, on his first admission, it was distinctly recognised through three shirts (two of them flannel), a waistcoat, coat, and top-coat; yet this murmur, which I especially investigated to determine the area of

propagation, is not audible as a murmur above the third rib, nor below the middle of the sixth interspace; nor farther to the left in the nipple line than a line descending perpendicularly from the anterior border of the axillary space; while on passing to the right it is already less rough at the left edge of the sternum, and is quite lost half an inch beyond its right edge.¹ But though I give this as an excellent illustration of the remarkable limitation of propagation, even in an exceedingly rough and loud presystolic murmur, you are not to conclude that this murmur is always limited to so small an area, because exceptions do occur, though these are certainly much rarer in regard to its propagation than in regard to its character. In accordance, therefore, with the laws of the propagation of murmurs already laid down, this position of audition, as we may term it, stamps this murmur as of mitral origin, and even hints its probable rhythm to the intelligent ear. The rhythm of a murmur is, as you are aware, its relation to the several physiological acts which constitute a complete cardiac pulsation—that is, which occupy the time comprised between two consecutive apex beats. During this period we have the ventricular systole, synchronous with the apex beat and the first sound; the ventricular diastole, synchronous with the second sound, and extending a little beyond it; the period of cardiac rest occupying almost all that remains of the soundless interval; and lastly, the systole of the auricles, which immediately precedes the ventricular systole running into it. In timing any murmur, therefore, we must take the greatest pains to discover whether it takes the place of either the first or the second sound, or if not, then we must ascertain what is the accurate relation of the murmur to these sounds, which of them it precedes, or which of them it follows, and at what interval. Now, in this matter there is this fallacy, that both first and second sounds are not always audible together at apex or base, as the case may be, either in health or disease; and when this is the case in disease, the murmur present is usually taken for the sound wanting. This is specially the case with the murmur of which I am at present speaking, for in the mitral region this murmur is not unfrequently followed by a single loud accentuated sound; and, accordingly, most students at once diagnose the case as one of mitral regurgitation (systolic bruit) with accentuated second sound. This state of affairs is by no means characteristic of the ordinary presystolic murmur, but it accompanies one form of it, of which I shall presently speak; and I mention it now, because the only means of correcting this erroneous diagnosis is to time both the murmur and the sound by placing our finger on the carotid artery, when the murmur will be found immediately to precede and to run up to the carotid pulse, with which the sound is distinctly synchronous. But

¹ W. C., Ward V.—The murmur in this case passed further to the right than usual. He has since died. His case will be detailed further on, where the reason for this will appear.

we know that the carotid pulse is synchronous with the first sound of the heart, and precedes the second one; the sound that we hear is therefore the first sound of the heart, and as the bruit immediately precedes it and runs up to it, it occupies the time of the auricular systole; and inasmuch as the ventricular systole is the first portion of the heart's action giving rise to audible or tangible phenomena, and is usually called the heart's systole *par excellence*, so this murmur has been termed presystolic; but, as I have already said, this is a misnomer—it is truly systolic in rhythm and character—but the systole on which it depends is that of the auricles, and not that of the ventricles; it is an auriculo-systolic murmur. In timing this murmur it is obvious that we must employ the carotid and not the radial pulse; for while the former is always synchronous with the ventricular systole and apex beat, the latter is even in health always delayed to an appreciable extent—one-sixth of a second; while in disease, especially such as interferes with the arterial contractility, this delay is notably increased, and sometimes amounts to an entire cardiac pulsation. A reference to the radial pulse is thus always embarrassing, and may greatly mislead, but a reference to the carotid pulse is a perfectly safe guide, provided we ourselves have senses educated sufficiently to appreciate the teachings obtainable by comparing an audible with a tangible phenomenon. As, in a pretty considerable experience of clinical teaching, I have rarely seen any mistake made in doing this, the difficulties in its way must be but slight; such as they are, they are readily surmounted by the repeated examination in this manner of hearts which are either naturally slow, or have had their action artificially retarded.

Much that is written as to the rarity or even non-existence of this peculiar murmur must surely be chargeable to inattention to this simple, efficient, and necessary diagnostic procedure. There are other murmurs besides this dependent upon mitral constriction, of which we shall presently speak; even this murmur is not always audible when its cause is present, still it is by no means unfrequent, and a due attention to the means described for ascertaining its rhythm and position of audition ought to leave no doubt as to its real character, and just as little as to its frequent occurrence. The peculiar position—in rhythm—of the presystolic murmur has given rise to an arbitrary regarding it as systolic or diastolic, according to the views of the observer. A simple reference to the carotid pulse is sufficient to correct this, and to prove as convincingly as anything sublunary can be proved, that this murmur is preceded by the long pause, and cannot therefore be diastolic, while it precedes both the apex beat and the short pause, and cannot therefore be systolic. With the term post-diastolic, which has been by some applied to this murmur, I have no sympathy whatever; it is an unmeaning expression of an assumed ignorance which does not really exist; for whatever murmur is neither diastolic nor systolic must of necessity

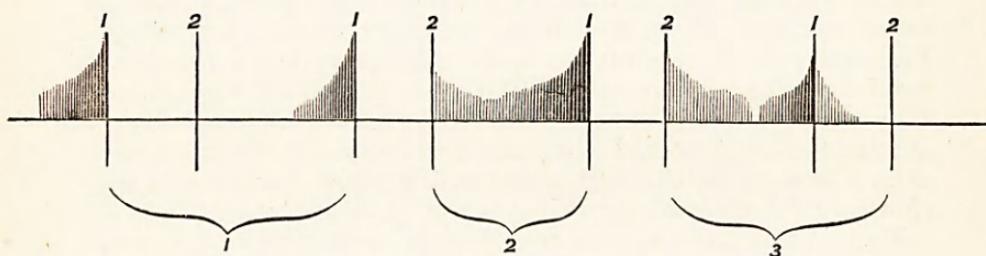
be post-diastolic; but as it can hardly occur during the post-diastolic period of rest, when all the causes productive of murmur are in abeyance, it must occupy the time which every physiologist knows to be that of the contraction of the auricle, and is therefore of necessity auriculo-systolic. It is further a direct murmur, a murmur accompanying the onward current of the blood in its natural course through the heart, forcibly produced by muscular contraction. We shall presently see that there are other murmurs, especially of the mitral valve, direct as to the natural current of the blood, but having all the softness characteristic of an indirect or regurgitant murmur, because they are actually diastolic in rhythm and unaccompanied by forcible muscular contraction. This, however, is not the character of the true auriculo-systolic murmur; it is short, because it sharply coincides with the contraction of the auricles; it is also rough, because it is a direct murmur produced by forcible muscular contraction. It has been asserted by some that this loudness and roughness is entirely dependent on the amount of constriction or roughness of the upper surface of the valve; that neither this nor the directness of the murmur are the sole causes of the roughness is conclusively proved by the remarkable manner in which this murmur occasionally disappears, temporarily or permanently, the condition of the valve remaining the same. Something in this may be due to the constitution of the blood, and something also to the varying power of the heart's action; but that these are not all-sufficient is shown by the occasional rapid alterations in the degree of audibility of this murmur—alterations which, as well as the occasional variations in the production and conduction of other cardiac murmurs, are as yet wholly inexplicable.

Various combinations of vowels and consonants have been employed to represent, phonetically, the sounds of cardiac murmurs; and the simple murmur I now speak of is probably that which is most susceptible of being thus treated; the symbols *Rrrb*, or *Vōōt*, when vocalized, conveying to the ear sounds almost identical with those produced within the heart; nay, more, the varying accent with which they may be pronounced accurately represents the changes which are found in different murmurs, or in the same murmur at different times, the last consonant in each symbol being coincident with the apex beat.

Furthermore, sounds are only audible vibrations; and in many cases these are to be felt as well as heard; thus, the rattle of carriages along a street produces a perceptible tremor of the houses in it; and if we strike a tumbler sharply so as to produce a musical note, the vibrations causing this note are readily felt on placing a finger on the edge of the glass, and the sound ceases at once when we stop these vibrations; nay, the sounds produced by friction of the moistened finger along the edges of glasses partially filled with water are not only to be felt as vibrations, but may be seen in the crispation of the water within them. So in like manner the vibra-

tions which give rise to cardiac murmurs may very frequently be felt by the finger at their point of origin; and as they are more readily felt the louder and rougher the murmur is, and as there are few murmurs, if any, so rough as this simple presystolic one, so it more frequently than any other gives rise to a distinct sensation of vibration which is to be felt over the mitral area, giving rise to what is termed the *frémissement cataire*, or purring tremor, rarely, if ever, absent in such cases, and equally with the audible phenomenon, which coincides with it and depends upon a common cause, remarkable for the striking manner in which it runs up to the apex beat and there ceases, which this tremor may be distinctly felt, just as the murmur is heard to do.

A murmur, then, presenting the characteristics just described, rough and capable of being vocalized by the sounds represented by the letters *Rrrrb* or *Vōōt*, which is separated from the second sound by a more or less lengthened but always readily appreciable interval, which distinctly precedes the apex beat and the carotid pulse, usually running quite up to them, but occasionally separated from them by an extremely short though appreciable interval, whose rhythm may be thus graphically rendered (fig. 1), and which is (almost)



invariably accompanied by a purring tremor over the mitral area, is invariably an evidence of mitral deformity, and is that to which alone is applicable the term, simple presystolic or auriculo-systolic. Once heard and recognised, we are sure that after death we shall find more or less constriction of the auriculo-ventricular opening, more or less deformity of the mitral valve; the murmur may disappear, but the lesion is permanent. The tendency of this murmur to disappear, temporarily or permanently, is in many cases somewhat remarkable, and has given rise to many unlucky *contretemps* not very creditable to practitioners of medicine. For instance—

CASE 1.—I well remember a case in which a patient with a disappearing presystolic murmur possessed quite a bundle of certificates from medical men, one half of which testified that he laboured under organic disease of the heart, while the other half certified, equally strongly, that he was altogether free from cardiac disease. He ultimately died, and the mitral valve was found to be deformed, the opening constricted, and the appendix of the left auricle filled with an organized clot. Of course in every such case there are

various subsidiary phenomena which tend to prove the persistence of the cardiac lesion, apart from the existence of a murmur; but of these I shall presently have to speak more at large; let this case be a warning to you, to pay more attention to those subsidiary phenomena, where you undertake to confirm or controvert the deliberate opinion of a competent medical man, and to avoid basing your opinion as to the existence of cardiac disease on the mere presence or absence of a murmur, either of which may sometimes mislead, though, as I have already said, such a murmur as that just described never does.

The condition of the valve usually, and so far as my own experience goes, invariably, associated with the murmur described, is that which has been termed the diaphragmatic valve, in which the two segments of the mitral are united and stretched like a diaphragm across the auriculo-ventricular opening; the valves themselves are thickened, especially at their edges; sometimes almost cartilaginous in character, their surface usually smooth, though occasionally their edges have a few small and frequently calcareous vegetations attached; the central opening may vary from a small buttonhole, into which the point of the little finger can scarcely be inserted, up to an opening not very much less than normal; in the latter case, however, if the murmur have been at all well marked, the vegetations will be found more numerous and larger than usual. Even where the murmur has been very loud, rough, and persistent, the valve is not therefore rougher or denser than usual; roughness of the murmur is quite independent of roughness of the valve, or even of any remarkable hypertrophy of the auricle, as is very well shown in the following case:—

CASE 2.—Margaret Ross was an inmate of Ward XIII. for a whole year, labouring under general dropsy, depending on kidney disease (large white), for which she was repeatedly tapped, etc. What chiefly concerns us now is, that she had a persistent and well-marked rough presystolic bruit, accompanied by a thrill at the apex. On dissection her kidneys were found diseased as expected, her heart was somewhat enlarged, weighing 15 ounces, with milk spots on its anterior surface; the left ventricle was in a state of concentric hypertrophy, but besides this its walls were considerably thickened (this depending on the kidney disease); the segments of the mitral valve were united and thickened throughout, but chiefly at their margins; their surfaces were perfectly smooth, and on the edges of the opening, which was so contracted as only to admit the point of the middle finger, there were one or two minute vegetations; the cordæ tendinæ were contracted and matted together; the aortic valves were competent and natural; the right side of the heart apparently natural.

This was a very well marked case, in which the post-mortem phenomena fully confirmed the diagnosis during life, as, I may add, invariably occurs in similar cases.

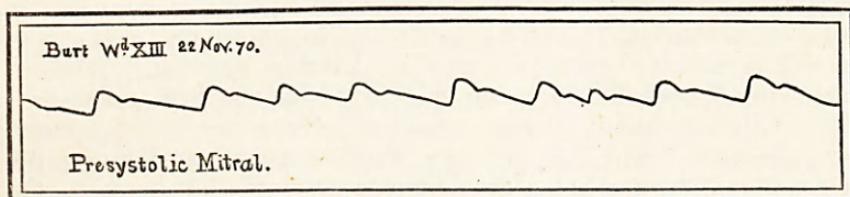
CASE 3.—William Craig had a presystolic murmur so loud and rough that I have selected it as a measure of the extent to which such murmurs could be propagated. In mapping out the extent of his murmur, I found it to extend so much further to the right than usual that the thought struck me, Is it possible that we can have in this case not only a mitral but also a tricuspid stenosis? But I dismissed the idea as in the highest degree improbable, and referred the great propagation to the loudness and roughness of the mitral murmur. The result shows that in this I was mistaken, though unquestionably there were no other symptoms present but the excessive propagation which could countenance any other opinion. The patient was anæmic, and there were consequently no jugular throbbings present, and the increased transverse dulness of the heart could not of course be regarded as any definite sign of tricuspid stenosis. The patient died of latent pneumonia following, and apparently induced by scattered patches of pulmonary apoplexy, both of which were recognised during life. On opening the thorax, the enormous size of the right auricle at once attracted attention. It measured inside eight inches and a half in circumference by two and three-quarters vertically, and contained a large clot, half an ounce of which was decolorized; its walls were comparatively somewhat thickened, but irregularly so, varying in thickness from one line to a quarter of an inch. The muscoli pectinati were singularly well developed. On looking down on the tricuspid valve from the auricular aspect, its segments were found matted together, and the opening so contracted as only to admit the point of the middle finger; the endocardium in its neighbourhood was slightly thickened; a few small vegetations were attached to the free margin of the valve. The right ventricle was slightly dilated; its walls not hypertrophied; the cordæ tendiniæ contracted; and no distinctive trace of the three segments of the valve were to be found. The left auricle was dilated so as to admit a ball two inches in diameter; its walls were not hypertrophied; its endocardium was thickened. The mitral valve from the auricular aspect scarcely admitted the tip of the little finger; its upper surface was covered by many calcareous spiculæ; its free margins beset by a few small vegetations. The left ventricle was apparently normal both as to its walls and cavity. The aortic and pulmonary valves were competent and healthy. The whole heart weighed nine ounces and a half. The rest of the dissection is omitted as unimportant for my present purpose. The boy's illness, according to his own statement, dated only a few months back. There was no history of rheumatism in either of these individuals.

Cases illustrative of this peculiar murmur and its accompanying lesion are of such common occurrence both in the wards and in the pathological theatre that no session passes in which you may not have repeated occasion to verify the statements made. I shall not therefore multiply them here, and shall also reserve statistical de-

tails till I come to treat of the relative frequency of the various forms of heart disease.

Of course, with a mitral valve deformed in this manner, closure of its segments is necessarily impossible, and regurgitation to a greater or less extent must of course be present, yet a systolic bruit is very frequently, as in the two cases related, entirely wanting, though occasionally, as I shall presently point out, the systolic bruit is the only one distinctly audible, while in yet a third series of cases both bruits are audible separated by the apex beat.

The pulse in this form of cardiac disease is weakened in proportion to the amount of stenosis present, and is more or less irregular, though not always markedly so, provided no pyrexia coexist; and the accompanying diagram may be accepted as a fair average graphical representation of its condition in such cases:—



But the murmur just described—though that which is certainly most characteristic of diaphragmatic mitral stenosis—is far from being the only one heard in such cases, and of the variously complicated murmurs which may be audible in such a state of the valves, the two following cases afford very striking illustrations:—

CASE 4.—Mary Macmurray, aged 31, admitted into Ward XIII. on 26th May 1870, complaining of great pain across the chest, loss of appetite, and general debility. She stated that she had never been very robust, and had suffered from acute and subacute rheumatism on three separate occasions; the first of these attacks occurred nine years ago, the second seven, and the third three years ago. She also suffers almost constantly from chronic rheumatic pains of her limbs and chest. Towards the close of her first attack her head was affected. About ten months ago she began to get more feeble and lost her appetite, suffering also from severe pains in the precordial region, and since that time she has gradually got worse. Her urine was found to be albuminous, containing one-fourth of albumen, specific gravity 1016, acid, normal in quantity, and contained epithelial, granular, and hyaline casts. This kidney affection was her more serious ailment, and was that of which, indeed, she ultimately died; but, in relation to our present subject, her thoracic symptoms were by far the most interesting, and were as follows:—Her pulse was 104 and feeble, both radial pulses alike, and both pupils normal. The heart's apex beat behind the fifth rib, as ascertained by percussion, and two inches and a quarter to the left of the sternum. One inch from the left edge of the sternum

the percussion sound was quite clear from the clavicle down to the upper edge of the second rib; from the upper edge of the second to that of the third rib, the sound on percussion was comparatively dull; and perfectly dull from the upper edge of the third rib to the lower edge of the fifth, where the tympanitic stomach sound came in. Along the upper edge of the fourth rib complete dulness extended for a distance of half an inch from the right edge of sternum to two inches and a quarter from its left edge, and comparative dulness for nearly one inch more. Along the lower edge of the second rib the dulness extended for a distance of two inches and three-quarters from the left edge of the sternum. In this dull portion between the second and third ribs on the left side, distinct pulsation is to be felt, less forcible, however, than that of the heart. On auscultating over the apex beat a distinct presystolic bruit was usually but not always audible; the systolic sound was observed roughened and occasionally replaced by a soft blowing murmur; the second sound is followed by a loud musical diastolic murmur. Between the second and third ribs on the right side the first sound was heard muffled, and there was considerable accentuation (sharpness) of the second sound, followed by a diastolic murmur. Between the second and third ribs on the left side close to the sternum, the second sound was more markedly accentuated, and the diastolic bruit more distinct: a little farther to the left the same sounds are heard, and a distinct sense of pulsation is conveyed to the ear by the stethoscope. The accentuation of the second sound and the diastolic bruit are, however, most distinct immediately behind the sternal edge of the second rib at the left side. Into the left subclavian the accentuation of the second sound was distinctly propagated, but not the bruit. Into the left carotid both sounds were propagated, but not distinctly; but into the right carotid and subclavian both sounds were distinctly propagated. On auscultating up the right edge of the sternum, the second sound and diastolic bruit were heard gradually to increase in loudness to the upper edge of the sternum, where it is joined by the first rib, but nowhere on the right do they attain the same loudness and distinctness as on the left. A slight humming murmur was occasionally audible in the veins. For the last month, the patient's urine became more scanty, uræmic vomiting and sickness were frequent, and she gradually sank, and died on the 21st December, the immediate cause of death being a pleuro-pneumonia absolutely latent, and entirely without any subjective symptoms whatever. Her cardiac symptoms remained unchanged. At the autopsy, on 23d December, the lower part of both the right and left lung were found to be hepaticized, and were covered externally by a thin layer of perfectly recent lymph, presenting a honeycomb appearance. The left lung was slightly retracted, uncovering the heart to a greater degree than usual. The heart itself was purse-shaped and somewhat enlarged, its substance healthy; the aortic valves were competent, but its

cusps were thickened and covered over their whole under surface by numerous vegetations; the mitral valve was thickened and contracted, scarcely admitting two fingers, and with some threads of recent lymph attached to its edge; the upper surface of the aortic segment of this valve was thickly studded with rough stumpy vegetations of varying size. The liver was healthy. The spleen weighed fifteen ounces, and on its posterior border had seven hæmorrhagic infarctions of a triangular shape, and varying from the size of a pea to that of a small bean (the results of embolism), otherwise it was healthy. The kidneys were slightly enlarged; the right weighed five, and the left six ounces. The cortical substance was lessened; the capsule natural, and when peeled off exposed a smooth organ. The intestines were congested, and the rectum and lower part of sigmoid flexure of the colon were thickened.

The next case is perhaps equally instructive, but wants the crucial decision of a post-mortem examination. I shall confine myself solely to the cardiac phenomena:—

CASE 5.—J. H., aged 18, was sent up to Ward XIII. convalescent from typhus from the fever house on 6th June 1871. She states that two years ago she had a severe attack of rheumatism which affected all her joints, but not her chest, and lasted for four months. After her recovery she began to suffer from pains in her cardiac region, palpitation of her heart, and shortness of breath on going up stairs. Three months before her attack of typhus fever, from which she has just recovered, she first observed some degree of swelling of her feet. Since her fever the pains in her chest have been more severe, but she has no dyspnœa while lying still in bed. Her pulse is 84, rather small, steady and regular; there is a perceptible thrill over the apex of the heart. The longitudinal dulness of the heart is normal; its transverse dulness in the line of the fourth rib extends from the right edge of the sternum towards the left for a distance of three and a half inches. The apex beat is between the fifth and sixth ribs, three inches and a half from the left edge of the sternum. On auscultation over the apex beat a somewhat prolonged murmur is audible; the first portion of which is rough, and precedes the apex beat, while the latter and softer portion follows it. Between the second and third ribs on the right side there is a systolic murmur prolonged upwards, and followed by a normal though somewhat feeble second sound. Between the second and third ribs on the left side, close to the sternum, there is a systolic murmur, followed by a markedly accentuated second sound, which is immediately followed by a soft, blowing diastolic murmur. This diastolic murmur ceases to be audible at a distance of two inches and one-third from the left edge of the sternum along the second interspace. Descending from the third rib at one inch from the sternum, this diastolic murmur continues audible till about the middle of the fourth rib, after which it ceases to be heard, the presystolic and systolic murmurs being alone audible beneath this

point. Over the sternum this diastolic murmur is only to be heard between the second interspace and the fourth rib. The systolic murmur is slightly propagated into the carotid arteries, as is also the aortic second sound which remains pure. During the progress of the case the ventricular systolic sound over the apex was frequently found absent, and the diastolic murmur at the base became more limited in its area. The patient was discharged improved on 12th August.

The murmurs in these two interesting cases differ considerably in some respects, and yet, if we analyze them, both cases will be found to belong to the same category—examples of which, though not very common, are yet by no means rare. And I shall first remark, that the systolic basic murmur on the right or aortic side of the sternum, in the second case, very probably depended on a similar roughened condition of the under side of the aortic semilunar valves, which was observed in Macmurray; that the murmur was not distinctly heard in her case (the first sound in that position was only muffled) is no proof to the contrary, as these anomalies constantly happen, but, on the other hand, it is also possible that it may have been propagated from the left side, in which case it belongs to quite a different category; at the same time, had this been its only source, it would scarcely have been propagated so distinctly into both carotids, at least we should not expect it to have been so. The first point having a direct bearing on the subject in hand—the diagnosis of mitral stenosis—is the occurrence in both of these cases of a diastolic murmur, loudest at the right edge of the sternum at the base of the heart. In H.'s case there could be no doubt as to the diastolic character of the soft blowing murmur; in Macmurray's case, her ordinary pulse of 104 was reduced by digitalis and the recumbent posture to 80 before I could positively satisfy myself that her musical murmur was truly diastolic.

The region of the pulmonary artery to which these murmurs belong, has been not inaptly termed the region of romance, because of the murmurs audible there, which have given rise to much speculation, and which nevertheless seem easily explicable. Laennec, it is well known, taught that the second sound was due to the contraction of the auricles; and Hope, though well aware of the production of the second sound by the closure of the semilunar valves, yet taught that "when the mitral valve is contracted, a murmur accompanies, and sometimes entirely supersedes, the second sound," the influence of Laennec's teaching helping no doubt to mar the excellence of his own observation. For the murmur of mitral stenosis never obscures the second sound, though it often, as in the cases just described, immediately follows it; sometimes, as in them, separated by an appreciable interval from the true presystolic murmur (fig. 3), at others including it and running right through the periods of diastole and rest up to the apex beat (fig. 2). In both classes the first portion of the murmur is distinctly soft and diastolic in charac-

ter, while the latter portion has a rough and systolic character, the direction of the current of blood being the same during both, clearly showing the influence of muscular propulsion in roughening the murmur. In Macmurray's case there is positive proof that the condition of the pulmonary valves had nothing to do with the production of diastolic murmur; the absence of any symptoms of disease of the right heart, in the other case, coupled with the great rarity of disease of the pulmonary artery, and the comparative frequency of similar diastolic murmurs in other cases of mitral stenosis, make it most probable that this diastolic murmur in all of them depends upon the same cause. The appreciable interval which existed between the diastolic and presystolic murmurs, in both cases, makes it impossible that prolonged auricular contraction, encroaching on the periods of rest and ventricular diastole, could have been the cause of these diastolic murmurs; for, in the face of a continuously contracting auricle, no theory of the production of these murmurs could account for a soundless interval interposed between a soft and a rough bruit, though it might explain the gradual roughening of the bruit towards its close. On the contrary, if we suppose two different causes acting in different directions to be at work in the production of these bruits, we have an efficient explanation of the difference in their character; and if we further suppose these causes to be separated by an interval, in the normal condition of the heart, we have also an efficient explanation of the pause which is occasionally interposed between the soft and the rough bruit, and we can also perceive a very plausible reason for the occasional absence of this pause. For it must be evident, that the more nearly the mechanism of the heart approaches the normal, so much the more closely will the physiological phenomena approximate those in health. The presence or absence of an appreciable pause in abnormal conditions will therefore be a measure of the amount of abnormality existing—a measure of the obstacle to the onward flow of the blood, of the degree of contraction present.

If we take an india-rubber bag-syringe, and, after emptying it of air, insert its nozzle into water, it will be found to fill with a rapidity proportioned to the size of the opening in its nozzle, into which, if any particle of dirt get, the bag either fills more slowly, or, if the opening be quite stopped, it ceases to fill or to dilate at all. So it is with the heart; in the normal condition of the auriculo-ventricular valves the diastole is completed at once—the blood not so much flowing freely into the ventricles, as closely following in a liquid mass the recession of their walls, for of course there is in the heart no vacuous cavity or air-filled space into which the blood can be, strictly speaking, said to flow. During the period of rest, the blood continues to pass into the heart, till the auricles, becoming stimulated by the distention, contract upon their contents, which they force into the already full ventricles—thus supplying to them that stimulus of distention necessary to induce their contraction

in its turn; and the comparative tenuity of the auricular walls exists probably quite as much because of the necessity there is that the cardiac contraction should commence there, as because of the auricles having less work to do. When, however, from any cause the auriculo-ventricular opening is narrowed, it is certain that the diastole must be prolonged, and this prolongation of the diastole must increase according to the amount of mitral stenosis present, until it not only encroaches on the period of rest, but may even occupy the whole of it, the ventricle filling so slowly that the stimulus of distention is felt by the auricle before the ventricular diastole is perfectly concluded. Under these circumstances, if the right cavities be relatively proportional, even though not quite normal, and the mitral stenosis considerable, the stimulus of distention may be more speedily produced on the right side than the left, and as the result of that we have a want of synchronism in their action, and a consequent want of synchronism in the closure of the aortic and pulmonary semilunar valves, and hence reduplication of the second sound—a phenomenon of such frequent occurrence in the history of mitral stenosis as to be of considerable importance in the diagnosis of obscure cases, being in many of these a tolerably permanent and by no means a casual or unfrequent occurrence. The flow of blood through the contracted valve in such cases of prolonged diastole may be altogether soundless, or it may be accompanied by a murmur which may be musical, as in Macmurray's case, or non-musical, as in H.'s case, but in all it is of a soft, blowing, diastolic character, and presents none of the roughness of the auriculo-systolic murmur, in which it not unfrequently terminates, and this notwithstanding that both are equally direct murmurs so far as the current of the blood is concerned. It seems probable that the musical character of the murmur in Macmurray's case was produced by the vibrations of the rough, stumpy vegetation covering the upper surface of the aortic segment of the mitral valve; it seems equally probable, however, that in many cases a distinctly humming, though perhaps less distinctly musical, character may be given to the murmur merely by the peculiar state of tension of the valve itself.

You will observe that, as in the normal condition of the heart there is a pause between the ventricular diastole and the auricular systole, so, the more closely the diseased heart approaches to the normal one, the more likely we are to have a pause between the diastolic and auriculo-systolic murmur, while the absence of any pause is, according to the view now taken, only a proof of the great amount of stenosis present; and you will observe that Macmurray's heart bears out this view, inasmuch as the pause was distinctly marked in her, while the opening in the mitral valve actually admitted two fingers, which indicates a by no means great amount of contraction. You will also observe, that this explanation of the production of a prolonged presystolic murmur is not only consistent with what we know of the physiological action of the heart, but

also with the character of the sounds heard, while it also does away with all the difficulties in the way of explaining reduplication of the second sound, as also those still greater difficulties of explaining how or when an auricle is to be filled, if we imagine that a bruit, occupying as it frequently does the whole of the diastole and rest, is produced by continuous auricular contraction.¹

Bruits such as these may be graphically represented by the second and third illustrations in diagram 1, the first exhibiting them when they are continuous, the second when, as in the two related, they are not, part of the shading to the right of the centre being omitted to represent the pause. Phonetically they may be vocalized by *rrrrrb*, or, when softer and more musical, by *roo-oo-oo-oo-b*, and when we have reduplication of the second sound by *roo-oo-oo-oo-b-ta-ta*.

The systolic bruit audible in the pulmonary region has nothing to do with mitral stenosis; in the cases related it partly depended on mitral regurgitation, but it is also heard where no regurgitation is present. I shall describe its mechanism in both of these instances on another occasion.

It is very well known that a constricted mitral valve is not always diaphragmatic in character, but is occasionally funnel-shaped, the opening being at the apex of the cone which dips into the ventricle. I have no dissections of such cases to relate, but have occasionally had cases which presented characteristics which I conceived to be due to this form of valve—these are prolongations of the murmur, followed by a loud and accentuated first sound. It is such cases which are so apt to be mistaken at first hearing for a systolic murmur with an accentuated second sound; a reference to the carotid pulse at once corrects this misconception. The murmur in this case is aptly vocalized by the sounds *roo-oo-oo-lúp*, and the perfect closure of the valve has seemed to me readily explicable by the ease with which the sides of a long and somewhat loose valve, with a small opening, may be collapsed one upon the other.

Such, then, are the murmurs specially distinctive of mitral stenosis; I shall subsequently take up the physical signs diagnostic of this affection when no murmur, or when only a systolic one, is present. The mere addition of an apex systolic murmur to those described as distinctive of mitral stenosis in no way affects the diagnosis, and its consideration is therefore for the present omitted.

¹ Macmurray's case has already been commented on in relation to the diagnosis of substernal aneurism, at p. 709 of this Journal for Feb. 1871. The occasional absence of the presystolic portion of the murmur in her case, gives it a very striking resemblance to that of Harriet H. (case 67), in Dr Hilton Fagge's interesting paper on the Murmurs attendant on Mitral Contraction, at p. 326 of Guy's Hospital Reports, vol. xvi. 1871.

(To be continued.)