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ON

TWO HEART CASES

WHICH PRESENTED A

RARE FORM OF IRREGULARITY.

FROM DR G. W. BALFOUR'S "CLINIQUE."

BY

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ON TWO HEART CASES WHICH PRESENTED A RARE FORM OF IRREGULARITY.

Writers on heart disease have frequently maintained that the close connexion of the muscular fibres forming the right and left heart ventricles render their independent contraction impossible. It is, however, a fact, well known to many vivisectors, that the ventricles in animals, whose heart has been exposed for observation, do not unfrequently, shortly before they finally cease to beat, show a certain degree of independence of action—most usually the right continuing to contract rhythmically, while the left remains motionless, or contracts less frequently than its fellow. The two following cases exhibited the same partial independence of the ventricles in the human subject; not, however, here forming a prologue to a speedy *exitus lethalis*, but appearing when the patients could look forward to at least some months of existence.

The cases came under my observation while I was acting as *house-physician* to Dr G. W. Balfour, who has kindly given me permission to publish my notes and tracings.

Case I.[1]—Beatrice Matherson, æt. 57, single. Admitted to Ward XIII. on 30th November 1875. (The patient was very deaf, and a complete account of her previous ailments was not obtainable.) Stated that, twenty or thirty years ago, she suffered from a severe inflammation of the front part of the neck, for which leeches were applied. Since then she has scarcely ever been entirely free from cough and shortness of breath on exertion. She has also had frequent vomitings of blood, but not during the last two or three years. The increasing want of breath, cough, and the more recently appearing swelling of the legs, have latterly obliged her to remain in bed. Never had rheumatic fever.

Status Præsens.—Patient is emaciated. Face, anxious. Orthopnœa. Legs, œdematous. Temp. 98·6°; p. 90; r. 44.

The dyspnœa which is present is much increased by very slight

[1] Dr Balfour has already given a short communication on these cases to the Ed. Med. Chir. Soc. *Ed. Med. Jour.*, June 1876, p. 1142.

exertion. Right half of chest is flatter and expands less than its fellow. Semi-circumference at the level of the sixth rib = R., 13½ in.; L., 14 in. Percussion note all over right lung is higher in pitch than over the left, the difference being most marked behind. The breathing over the right side is harsh, with prolonged expiration, and is accompanied posteriorly and at anterior base by medium fine crepitation. On the left side the vesicular murmur is also harsh, but less so than on the right; on the left side also there is crepitation posteriorly. Radial pulse is somewhat irregular, both in time and force. Exterior jugulars pulsate, but the valves are competent. Apex beat of fair strength is felt between the sixth and seventh ribs, 3½ in. to left of midsternum. Deep dulness of the heart measures transversely 6 in., there being 4 in. of dulness to the left, and 2 to the right of the middle line. A murmur accompanies the first sound, and is loudest at the apex. A systolic murmur, which is heard over the right ventricle, differs somewhat in character. Liver dulness in mammillary line 4 in. Urine—12 oz., dark, and gives ¼ albumen on testing.

The records, taken during the three and a half months which the patient spent in hospital, for the greater part, do not bear on the special phenomenon which leads me to report the case, and are too long to be given in detail. I summarize, therefore, briefly. She suffered five or six times during her stay from pulmonary embolism with the usual symptoms and signs, viz., sudden localized pain, with increased dyspnœa. With care, circumscribed dulness on percussion was usually found, and, 24 or 48 hours later, the sputa contained small quantities of blood. Occasionally she was troubled with intense hyperæsthesia of the skin of the front of the chest, and indeed was never entirely free from a slight degree of this. More than once she suffered from obstinate vomiting, not to be allayed by the ordinary means. After being in hospital about three weeks, and being treated with digitalis (10 m. of the tr. every 4 hours), the pulse, usually 80 or 90, was found suddenly to have fallen to 44, having been 86 at the previous evening visit. It was of fair strength and tolerably regular. On further examination the other cardiac signs were found to have undergone a very marked change. The jugulars were now widely distended and pulsating strongly, not, however, synchronously with the carotids, but alternating with them in their beats, in such a way that the carotid pulse was accompanied by a slight venous pulse, and followed after a short interval by a strong venous pulsation coming alone. There was—

1st. Simultaneous pulse in the carotids and jugulars, that in the latter being very weak.

2d. After a short pause, a strong jugular beat without that of the carotid.

Then came a longer pause than the first, followed by the synchronous arterial and venous pulse. The tracing G, taken from

the jugular bulb, illustrates this better than any description can do. The smaller of the two waves there represented was synchronous with the arterial pulse. The larger succeeding wave came without an arterial beat. The brachial artery and vein showed the alternating character of the pulsations even better than the vessels of the neck, as the pulsations in both were visible. The apex beat was also modified in rhythm, a strong beat corresponding to the arterial pulse, while a weaker followed and corresponded to that in the veins. The tracing D, taken from the apex beat of the other patient, where the phenomena were the same, illustrates the inequality of the succeeding impulses, and the bigeminal character of the rhythm. The heart was beating at 88, the pulsations in the radial being 44. The first of the twin apex beats was more pronounced over the apex, while the second was strongest over the right ventricle. Each impulse was accompanied by a first sound and a murmur, and followed by a second sound. The sound and murmur accompanying the first twin beat were loudest over the apex; those with the second twin beat were heard best at the lower end of the sternum. The second sound of the first of the twin impulses was loudest at the aortic area; that of the second twin beat, over the pulmonary area.

After this changed rhythm had existed for about half an hour, it suddenly gave place to the usual rhythm, and the signs were the same as those noted on admission. Patient stated that, while the above described irregularity was present, she felt that something unusual was going on in her chest, causing her some uneasiness but no pain. She had occasionally experienced the same sensation for several months before. While in the Royal Infirmary this irregularity returned often enough to enable me to verify completely the notes first taken, and to obtain numerous tracings.

Frequently, by pressing over the left carotid region,—a proceeding which caused some pain,—I was able to change the rhythm of the heart from its usual to its irregular beat. Later on, however, pressure on the indicated spot ceased to produce any appreciable influence on the rhythm. The rest in bed and the digitalis at first produced something of their usual effect, but afterwards she got worse and worse, and died on 18th March 1876.

Sectio Cadaveris, condensed from Dr Wyllie's report.—Heart much enlarged. Left ventricle somewhat hypertrophied, its wall measuring $\frac{3}{4}$ in. in thickness. Auriculo-ventricular orifices much enlarged, the right admitting seven, and the left four fingers. The mitral and tricuspid valves not diseased. Advanced sclerosis of aortic wall with calcareous plates. Over the right lung were dense old pleuritic adhesions, and the lung tissue was dense and dark in colour, with here and there patches of recent pulmonary apoplexy. Liver weighed 2 lb. 10 oz., congested and somewhat fatty. Kidneys, each, 5 oz., congested and slightly contracted.

Case II.—Euphemia Lawson, æt. 40, widow, in service as cook. Admitted 9th February 1876 to Ward XIII., complaining of shortness of breath, pain in the left side, and swelling of the legs.

Patient has been twice under Dr Balfour for dilatation of the heart due to "heart-strain." The case is of much interest from the remarkably complete disappearance, under treatment, of the local signs and general symptoms from which the patient suffered. A report of her case is given by Dr Balfour in his recent work.[1]

The circumstances of the patient obliged her to return to service, and again, for the third time, her heart gave way from work too hard for her powers.

Never had rheumatism, and enjoyed good health up till eleven years ago, when, while at Woolwich, she had a severe attack of ague.

Status Præsens.—Expression anxious. Muscles soft. Considerable emaciation. Pulse small and weak, with occasional irregularity. Has often palpitation and pain in cardiac region. External jugulars dilated and pulsating. Venous valves incompetent. The "Angulus Ludovici" exaggerated to an unusual extent. Diffuse, firm, apex-beat in fifth and sixth intercostal spaces, $3\frac{3}{4}$ inches to left of midsternum. Transverse deep heart-dulness extends at fourth rib from $1\frac{1}{2}$ inches to the right to 4 inches to the left of the middle line. Upper margin of dulness, in the left parasternal line, at the third costal cartilage. A systolic murmur with part of a first sound audible over whole cardiac area, with its maximum intensity at the apex. The murmur heard on the tricuspid area has an easily distinguishable difference in character. Pulmonary second sound much accentuated. Percussion over the lungs gives a normal note everywhere. Expectorates a large quantity of seromucous fluid. Liver-dulness $4\frac{3}{4}$ inches.

Treatment.—

℞ Ammon. carb. ʒj.
Inf. digitalis ℥vi. s.
Sig. A tablespoonful thrice daily.

The patient was two and a half months in the Infirmary, and, as before, I prefer to summarize my notes. Her ailments were mostly due to repeated embolisms, both in the pulmonary and systemic arteries. The history of the case records that she suffered from a perfect "shower" of such plugs. The pulmonary embolisms were in two cases the cause of localized pleuritis, which at one time raised the temperature to 103°. The clots in the systemic arteries chiefly lodged in the spleen and kidney, but a few days before her death the brachial artery was occluded at its lower end by an embolus. The temperature and the quantity of urine varied incessantly from such causes. It was about a month after her admission that the same form of irregularity which was present in

[1] *Clinical Lectures on Diseases of the Heart.* By G. W. Balfour, M.D., etc. London: 1876, p. 173.

the former case first showed itself. It came with the same suddenness, and resembled in detail so closely that presented by Beatrice Matherson, that I need not enter into the details for a second time. The sphygmograms A and B show the usual pulse, and that when the irregularity was present, while the cardiograms C and D show the corresponding change in the heart-beat. In E the pulsation of the jugular bulb is seen. It is noted that the irregularity in this case came and went without apparent cause, nor was it possible to produce it here by pressure over the carotid of either side, though here also pressure on the left carotid caused unusual pain. Patient also occasionally suffered from hyperæsthesia of the skin of the chest, and to a lesser degree of that of the limbs. Twice she suffered from uncontrollable vomiting, lasting several hours. The ever-recurring embolisms gradually reduced the patient to the last extreme of misery, from which she was relieved by death on 29th April 1876.

Post-mortem.—I give Dr Wyllie's report, as far as concerns the heart, in full. "Heart enlarged, weighing 1 lb. 2½ oz. Right auricle and ventricle were much dilated, and the tricuspid orifice was enlarged, admitting eight fingers. The auricular appendix was filled with a thrombus, which was evidently somewhat old. It was adherent at its periphery to the endocardium, and its centre was partially reduced to a soft yellow pulp by fatty degeneration. The visceral pericardium covering the appendix was white and opaque from chronic inflammatory thickening. The left auricle and ventricle were considerably dilated. The muscular wall of the ventricle was slightly hypertrophied, measuring $\frac{5}{8}$ inches in thickness. In the auricular appendix of the left auricle were several small gray thrombi about the size of peas. In the cavity of the ventricle there were also a number of thrombi, and two of them of large size, being respectively that of a walnut and of a filbert. These were of a dirty-gray colour and firm consistence. They presented a reticulated arrangement, rather delicate, of the fibrin superficially, and, on being cut into, the larger of the two was found to present a collection of fatty matter in its centre near one extremity, and a serous cyst near the other. The mitral orifice admitted four fingers; cone diameter, 1·55 inch. The mitral and aortic valves presented atheromatous thickening, but otherwise natural."

Lungs.—Pleuritic adhesions on both sides. Fibroid induration of posterior and lower half of right lung. At upper part of indurated portion a wedge-shaped embolic infarction. *Left Lung.*—In inferior lobe, a large recent pulmonary apoplexy. Spleen and kidneys presented each several cicatrices of embolic processes.

The clearness and sharpness of the signs presented by these two cases, together with the fact that other well-authenticated cases are to be found in medical literature, render it superfluous for me to use arguments to prove that this form of irregularity can only be explained by a more or less independent action of the two ventricles.

Before referring to the few analogous cases which have been reported, I may call attention to a slight difference in the form of the irregularity which these two patients presented. A comparison of the tracings E and G, both from the jugular bulb, the former from Case II. and the latter from Case I., shows that they have in common two large elevations corresponding to the twin heart-beats. It will be seen, however, that in G, the first elevation, that synchronous with the first beat, is much lower than the corresponding elevation in E, or than the elevation which succeeds it, and corresponds to the second twin-beat. The cause of this can only be sought for in an inequality of the successive contractions of the right ventricle in Case I. So that the right ventricular rhythm in this case presents a triple periodic deviation from the normal.

1st. It is irregular as to time, having the bigeminal rhythm.

2d. It is irregular as to force, a weak being succeeded by a stronger beat in regularly-succeeding pairs.

3d. It is irregular as to its relation with the contractions of the left ventricle.

In Case II. the second character of the irregularity is wanting. The further difference in the details of the two tracings E and G may satisfactorily be accounted for by the existence of a higher vascular tension and greater insufficience of the tricuspid valve in Case I., resulting in a tracing which follows more closely the typical ventricular curve made known by Marey and Chauveau. And here I may observe that, by the aid of a delicate recording instrument, tracings from the pulsating veins in cases of tricuspid insufficience are capable of giving valuable information as to the condition of the auricle and the degree of insufficience of the valve. I hope, in a future communication, to describe such an instrument, and to demonstrate the diagnostic value of such venous tracings. Leaving the action of the right heart, that of the left may be briefly noticed. The pulse of the carotid and radial beats only with the first of the twin cardiac impulses; but the tracing B shows, in the descending line, a slight rise which I am inclined to ascribe to a small wave sent out from the left ventricle at the time of the second twin contraction. The sphygmograms given by other observers from analogous cases render such a supposition probable, in which case, the same form of irregularity with its triple character would hold good for the left ventricle as well as for the right.

The possible occurrence of an independent action of the two ventricles is mentioned by various authors, without, however, the well-characterized irregularity here treated of being observed by them. Thus, among others, Littre[1] and Berard[2] remark that, in cases of great irregularity, the two ventricles seem to lose, in some degree, their synchronism of contraction. Da Costa,[3] in cases of

[1] *Dict. de Med.*, 2d edition, tome viii. [2] *Ibid.*

[3] *American Journal of Medical Science*, 1871.

what he calls "irritable heart," but which are now mostly termed "heart-strain cases," mentions that the heart sometimes beats twice for one pulsation at the radial artery. A case also is recorded by Barr[1] where there were two heart impulses for each pulse at the wrist; and in this case I imagine the irregularity was the same as in the above-reported cases, except that there was no venous pulsation—the absence of which would very materially obscure the nature of the case. Such cases remind us of Laennec's[2] "intermittences fausses," where, of two consecutive heart impulses, only one is represented by a pulsation of the radial. This author also describes a form of irregularity which seems to be closely related to the form in question. In considering his remarks, it must not be forgotten that he believed the second sound to be produced by the contraction of the auricles. He writes,[3] "It sometimes happens, though rarely, in palpitation of the heart, that each contraction of the ventricles is followed by several successive auricular contractions, which, joined, do not take up more time than one ordinary contraction. I have sometimes counted, in these kinds of palpitation, two pulsations of the auricles for one of the ventricles; at other times there are four; *mais le plus souvent le nombre de ces contractions successives et correspondantes à une seule contraction des ventricules est de trois.*" One would feel inclined to put this triple second sound down to a variety of reduplication such as is common enough, were it not that the author mentions three sounds as being the more common, and from his mentioning, further on, the difficulty of deciding in the case of three sounds following a heart-beat whether they are caused by a triple "auricular" contraction or by two ventricular contractions following one another closely.

The first observer, however, who clearly demonstrated the existence of a well-defined form of irregularity such as the two foregoing cases presented, was Charcelay,[4] who gives three cases exhibiting various differences in the character of rhythm present, most of which have also been found by later observers.

The forms of irregularity which he found were—

Case I. (*a*) Two contractions of the right with only one of left (most usual).

(*b*) Where a synchronous contraction of both ventricles was followed by a contraction of the right ventricle alone, that being followed by one of the left alone, after which came again the synchronous systole of both ventricles.

(*c*) Two contractions of the left with only one of the right ventricle.

[1] *Dublin Journal of Medical Science*, 1876.

[2] *Traite de l'Auscultation Mediate*, 2d edition. Paris, 1826. Tome ii. p. 472.

[3] Laennec, *l. c.* p. 471.

[4] Mémoire sur plusieurs cas remarquables de défaut de synchronisme des ballements et des brüits des ventricules du cœur. Par M. Le Dr Charcelay. *Arch. Gen. de Med.*, 1838, tome iii. p. 392.

Post-mortem.—Hypertrophy without dilatation; tricuspid insufficience; mitral orifice and valve normal; double pneumonia.

Case II.—The irregularity observed was of two varieties.

(*a*) Two contractions of the right with only one of the left ventricle (most common).

(*b*) Two contractions of the left with only one of the right ventricle (rarely).

No autopsy.

Case III.—Here jugular pulsation was not present. There were two heart-beats with sounds, the first only being accompanied by an arterial pulsation.

Post-mortem.—Contractions of the segments of the mitral and tricuspid valves (insufficience of the valves and stenosis of both auriculo-ventricular orifices).

More recently three cases presenting occasionally the same form of irregularity have been recorded by Leyden.[1] His first case is apparently one where the ventricles alternated in their contractions, each apex-beat being produced by one ventricle alone; but as no venous tracing is given, it is possible that the right ventricle may have taken part in the first twin-beat, as in Beatrice Matherson's case, where the two sides were at first believed to alternate till the tracing cleared up the question.

Professor Leyden's two later cases had two contractions of the right, with only one of the left ventricle, the latter corresponding to the first twin apex-beat—the same form which Charcelay found to predominate in his first two cases.

In the first case recorded by Leyden, the signs pointed to aortic and possibly also mitral stenosis with tricuspid insufficience. The second case showed insufficience of the mitral and tricuspid valves, and the third mitral insufficience with some stenosis of the orifice. Four cases of this irregularity are recorded by Fraentzel,[2] in which two twin heart-beats were accompanied by one carotid beat, corresponding to the first of the heart-impulses. There is no mention of a venous pulsation in any of these cases, but Professor Fraentzel notes that the sounds of the second twin heart-beat, that, unaccompanied by a carotid-pulse, were not weaker than those of the preceding heart-impulse.

The pathological conditions present were—

Case I. Large pericardial exudation.

Case II. Dilatation and hypertrophy of the right and left ventricle without valvular affection.

Case III. Aneurisms of the ascending aorta with aortic insufficience. Hypertrophy of both ventricles, especially of the left. Compression of both *vagi*.

Case IV. Great dilatation of both ventricles with slight hypertrophy; valves unaffected. Thrombi in both ventricles.

[1] Virchow's *Archiv.*, xliv. s. 365; and Zwei neue Fälle Ungleichzeitiger Contraction beider Ventrikel, Virchow's *Arch.*, bd. lxv., H. 2. s. 153.

[2] *Charité Annalen*, 1874 and 1875 (published 1876 and 1877).

Finally, in August of this year, Schreiber[1] has given several interesting cases resembling more or less closely those already given. The greater part of his cases recovered, and it is to be noticed that he, as well as Fraentzel, lays great weight on the connexion between this form of irregularity and the pulsus bigeminus.

The question naturally arises, whether or not this special variety of irregularity be of any diagnostic value, or can be held to indicate any special heart affection. Professor Leyden, from the fact that his three cases suffered from mitral insufficience, was led to conclude that this was the dominating factor in its production. He gives a very ingenious theory as to the mechanism by which mitral insufficience can produce this irregularity, and considers that the right ventricle, contracting twice as often as the left, compensates, in some measure, the insufficience of the mitral valve. The propositions of the distinguished Berlin professor seem at first sight to explain satisfactorily the nature of the phenomena, but a consideration of the analogous cases reported by others shows that neither is mitral insufficience constantly present, nor does the form of the irregularity admit any theory of a compensating action of the right ventricle, which, as in Charcelay's cases, may beat at half the rate of the left. On the other hand, cases of mitral insufficience and relatively increased pressure in the right ventricle are daily occurrences, while this form of irregularity is certainly rare, though perhaps less so than is generally believed: so that it is scarcely possible to accept a mechanical cause such as that which Leyden has advanced. But if mitral insufficience be not the only and the direct cause of this irregularity, it has certainly something to do with its appearance, as an examination of the above noted cases will show. But it must be remembered that, as the compensating hypertrophy begins to fail, irregularity is rarely absent in mitral cases, whether of simple insufficience, or of stenosis combined with insufficience, as is usually the case. In such conditions the irregularity assumes many forms,—either the *delirium cordis* which often predominates, or intermissions, or the pulsus bigeminus or trigeminus, or a combination of some of these. They all have for their original cause the mitral insufficience, but the special form assumed by the irregularity seems to be governed by some other factor.

The observations of Klebs[2] and of Hofmokl[3] on the heart rhythm of dogs, submitted to experimental conditions, might seem to favour the view advanced by Professor Leyden. Klebs, after causing mitral insufficience by his *valvotome*, and allowing the dog to recover from the shock of the operation, took tracings from the right heart and the femoral artery simultaneously, and found that

[1] Ueber den Pulsus Alternans, etc., von Dr J. Schreiber, *Arch. f. Exp. Path. und Pharmacologie*, bd. xvii. s. 317.

[2] Plager *Medicinische Wochenschr.* Jahrg. 76. S. 9.

[3] Stricker's *Medicinische Jahrbuch*, 1875.

while the left heart beat at 117, the right beat at 220 per minute. It is doubtful if the well-characterized form of irregularity which we here treat of was present in this case, or only a periodic irregularity, as no tracings are given. The conditions, however, under which the observation was made, presented many possible causes of error. When the lesion of the mitral was produced both carotids were opened, the one for the kymograph canula, and the other for the *valvotome*, and in removing the latter a piece of the artery 5 centimetres long was torn away, the wound healing by granulation. Under such conditions, it is scarcely possible to believe that the vago-sympathetic cord could escape all injury. Besides, when the tracings were taken, a glass tube was passed by the jugular vein into the right heart. To assume, in this experiment, that the unequal contractions of the ventricles were simply and solely due to the valvular lesion seems scarcely justifiable, considering that clinical experience clearly enough teaches us that, in simple mitral insufficience, such an independence of the ventricles is a rare occurrence. Hofmokl also found the right heart beating faster than the left when the pressure in the right ventricle was increased, that in the left being reduced. His tracings show that the heart beats with considerable regularity in this abnormal manner. But here the conditions were even more complicated than in Klebs's observation. The dog was curarized, the vago-sympathetics were cut, and then the artificial respiration which was first used was stopped, causing asphyxia. With so many factors present it seems illogical to choose the changed pressure as the immediate cause of the new rhythm, seeing that the others also were necessary for its production. Moreover, Schreiber, who repeated the experiment under the same conditions, was unable to obtain the results given by Hofmokl.

The opinion given by Schreiber and Fraentzel is, that the form of irregularity is to be considered as a variety of the "pulsus bigeminus." I cannot see that we are any wiser from such an explanation, and I am inclined to believe that it is giving an importance to the pulsus bigeminus which it by no means possesses. Traube[1] brought the "twin pulse" into prominence by claiming for it an important prognostic value as presaging a speedy lethal termination of the disease in which it showed itself, by attempting to show that it was due to a special definite condition of the vagus, viz., paralysis of the spinal part of the inhibiting nervous system with excitation of the cardiac part. Since, however, later observations have shown that the mechanism given by Traube of the production of the pulsus bigeminus is more than doubtful, and that it possesses no value whatever as a lethal sign, seeing that cases where it is observed frequently enough end in recovery, it will be seen that this twin pulse loses its importance

[1] *Gesam. Beitrage* and *Berlin Klinische Wochenschrift*, 1872. Ein Fall vom Pulsus bigeminus nebst bemerkungen.

as a "landmark" among the forms of irregularity. It would, therefore, be quite as rational and as useful to call the form of irregularity which we are considering an *abart* of the pulsus intermittens, or a variety of the simple aperiodic irregularity of the heart, as it is to call it a modification of the pulsus bigeminus, seeing that it is undeniably a form of intermission, and that it is closely related to simple irregularity which, in most of the cases recorded, immediately preceded its appearance. I willingly admit, however, that it has a close relation to the pulsus bigeminus, as indeed it has to the other forms of irregularity.

One other bearing of the question must be considered, viz., the influence of digitalis in causing this form of irregularity. In most of the cases recorded, as in my own two, it did not appear until after the patient had been treated by digitalis for some time. The observations of Böhm [1] on the effect of digitalis on the frog's heart, seem to have a direct bearing on this question. This observer found that sometimes in the "digitalis heart" the tracings showed a typical bigeminal rhythm,—a fact which has been verified by many observers both for the hearts of cold and warm blooded animals.

More interesting, however, is another fact observed by Böhm, viz., that sometimes during diastole part of the ventricle (frog's) remained contracted, while the rest distended with the blood. These partial diastoles, he found, may change places with those remaining contracted, so that it may happen that the right and left halves of the ventricle, or the two corners of the base, may contract alternately, as in the normal action of the auricle and ventricle. As before remarked, the observations where a pulsus bigeminus and other forms of irregularity resulted from the action of digitalis are exceedingly numerous; but that, in the cases here considered, the irregularity was simply due to the digitalis, is sufficiently disproved by the fact that, in two at least of these, the irregularity appeared although the drug had not been previously administered. It would thus appear that mitral insufficience, right-sided congestion, and digitalis have all some influence in causing this irregularity, while by no one of them, nor indeed by all combined, is it invariably produced. The truth would seem to be, that irregularities of the heart's action are produced by a condition of the regulating nerves of the heart, the same or nearly the same as that which the above-mentioned causes induce.

As to the nature of this condition of the nerves which causes irregularity, much valuable information has been gained by recent researches, most of them conducted in Ludwig's laboratory. The degree of tonus which the vagus nerve presents, in comparison with the amount of excitation of the accelerating nerves and of the automatic intracardiac arrangement, may, I am strongly inclined to believe, be considered as lying at the root of the matter. In other words, basing my theory on the observations of Von

[1] Böhm, *Pflüger's Arch.* Bd. v.

Bezold,[1] Bowditch,[2] Mayer,[3] and others, on the antagonism of the accelerating and inhibiting nerves of the heart, and finding such a theory supported by the facts of clinical observation, I am inclined to believe that irregularity of the heart is due to an "interference" of the opposed action of the inhibitory and accelerating nerves; assuming, as is justifiable, that the automatic intracardiac nerves act with the latter as regards this question. Such a theory will be seen on consideration to mean simply *relative* weakness of the inhibitory nervous influence. To consider fully the merits of such a doctrine and its practical importance, considering the many therapeutic remedies which act on the vagus, or to review the facts which support it, would at present lead me too far; and I content myself with barely giving its outline. It will be seen, however, that whether this theory be well founded or the contrary, it does not bear directly on the nature of our special form of irregularity, but on irregularity in general. The much more subtile question as to why, in a given case or at a given time, one form of irregularity presents itself rather than another, I must also leave untouched. In conclusion, I may call attention to the symptoms which my two cases presented, pointing towards disease or greatly altered condition of the vagus (pain on pressure, obstinate vomiting, etc.), and to the fact that, in one of Fraentzel's cases, where no mitral lesion existed, the vagi were compressed by an aortic aneurism.

Explanation of Figures.

A. Usual pulse from Case II. *B.* When the irregularity was present (both by Marey's sphygmograph). *C.* Usual heart-beat of Case II. *D.* Abnormal rhythm of the same. *E.* From the jugular bulb of the same.

F. Venous pulse from the jugular of an emphysema case with tricuspid insufficience. Given to show an ordinary venous tracing taken by the same instrument as gave the other tracings.

G. From the jugular bulb of Case I.

Note.—It should be mentioned that the clockwork of the instrument by which the above tracings were taken moves at twice the usual speed.

[1] *Innervation des Herzens*, p. 297, 1863.

[2] Ueber die Interferenz des retardirenden und beschleunigenden Herznerven.—Ludwig's *Arbeiten*, 1873.

[3] Studien zur Physiol. des Herzens. Sitzungsber, d. k.—*Akad. zu Wien*, Bd. lxviii.

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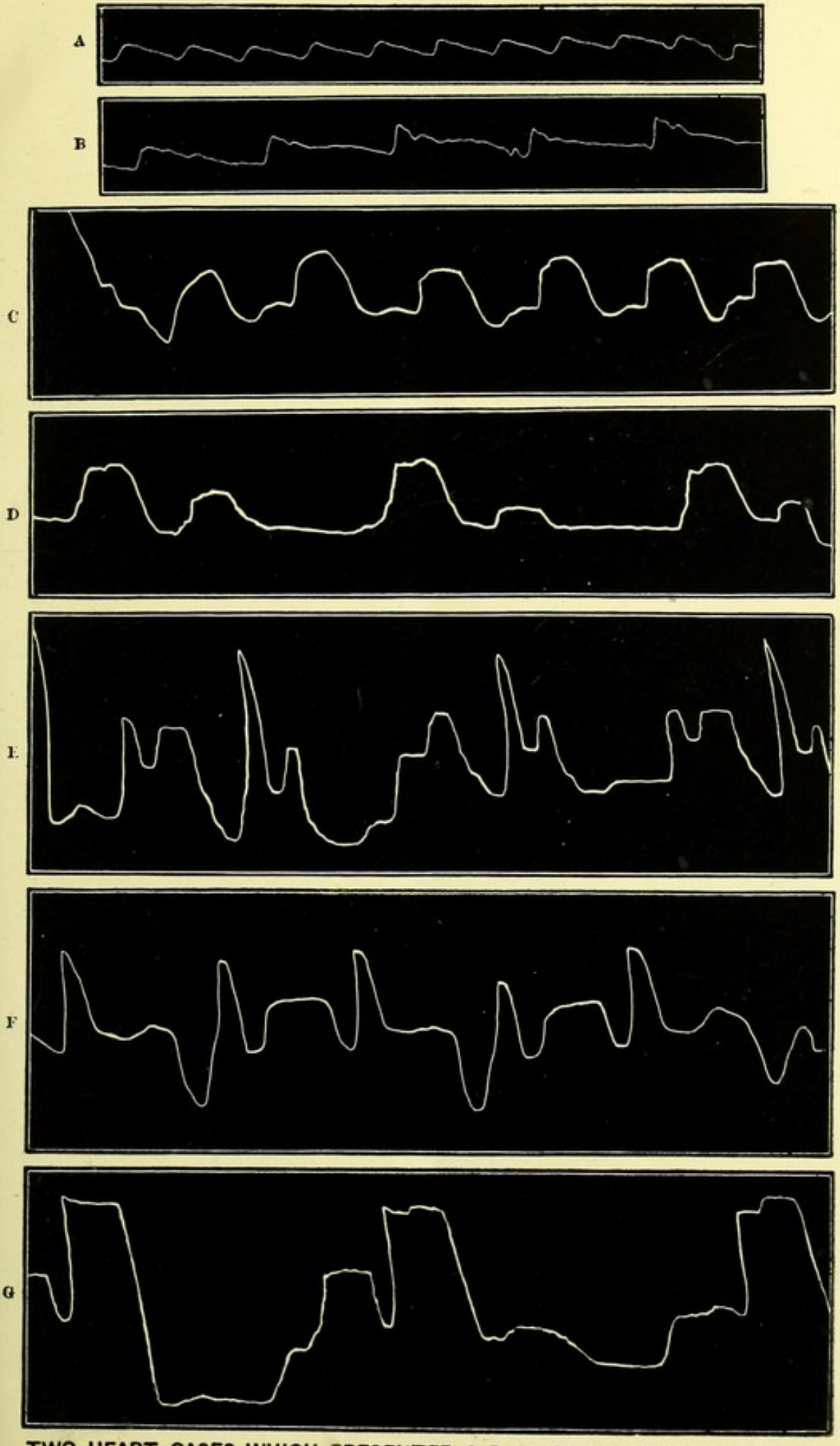

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