The interesting points of this case were the facts:

1. That the aneurysm must have been one occurring in the superior mesenteric artery in its course behind the pancreas, remnants of the arterial wall being found lying flat on the posterior wall of the cavity.
 2. That the gradual dilatation of the large aneurysmal cavity had exercised a traction on the aorta itself, so that a fusiform aneurysm was formed.
 3. That there was a rotation of the aorta, in that the opening of the coeliac axis artery and what must have been the opening of the superior mesenteric artery originally, were found on the right side of the aortic aneurysm.
 4. That there must have been a gradual and persistent dissection in the upward direction to the lower surface of the liver where the rupture eventually took place, as is evidenced by the thickening and induration of the walls.
- For permission to publish this case I am indebted to the Medical Superintendent of Addington Hospital.

ELECTRO-CARDIOGRAPHY AND ITS IMPORTANCE IN THE CLINICAL EXAMINATION OF HEART AFFECTIONS.

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(Continued from page 1423.)

PART II.

The Auricular Summit in Mitral Stenosis.

THE summit *P*, which corresponds to the contraction of the auricles, is small and pointed or rounded in most normal electro-cardiograms from lead *II*. As a rule its height does not extend for more than one scale division. In mitral stenosis, where there is hypertrophy of the auricular musculature, this summit is considerably modified and is of diagnostic importance. It is generally broad, flat-topped, and bifurcates in its centre (the last-named feature is not of necessity pathological), its height is greatly increased, it often extends to two scale divisions (Fig. 6; see also Fig. 4 *II* of previous article) and may amount to three or even more millimetres.

Fig. 6.—An electro-cardiogram (lead *II*) from a case of mitral stenosis. It shows the exaggerated *P* summit, which is broad, flat and divided. This picture is common in mitral stenosis.

The sign is of chief clinical value in cases of mitral stenosis in which murmurs are absent or obscure, and in such cases galvanometric examination may decide an otherwise doubtful diagnosis.

"As-Vs" Interval.

The normal heart beat consists of a sequence of chamber contractions. The contraction begins in the auricle and having passed through it is transmitted to the ventricle through the specialized tract of tissue known as the auriculo-ventricular bundle; the ventricle having received both its charge of blood and impulse from the auricle, contracts. There is an appreciable delay between the contractions of auricle and ventricle in a normally acting heart, and the length of interval between the onsets of the contractions is taken as a measure of the functional efficiency of the bundle in question. This interval is readily ascertained in human electro-cardiograms. It is represented by the distance from the commencement of the auricular summit *P* to the commencement of the ventricular summit *R*. In normal electro-cardiograms this *P-R* interval measures between 0.12 and 0.18 second.

But in pathological hearts the interval is often greatly increased; it often reaches 0.3 second (Fig. 7) and may extend on occasion to as much as 0.4 second. Prolongation of this interval is the first of a series of extremely

interesting and important phenomena which are spoken of collectively as "heart-block," phenomena which are due to impairment of the tissue functions in the tract which

Fig. 7.—An electro-cardiogram from a case of subacute infection of the bladder. The *P-R* interval is prolonged; there is hesitancy in the transmission of the impulse from auricle to ventricle, and consequently evidence of damage of the tissues joining the auricle and ventricle. The disturbance in conduction was the sole sign of myocardial disturbance in this patient at the time when the curve was taken.

conveys the contraction impulse to the ventricle. The impairment of bundle function produces delay or hesitancy of the impulse transmission, which can be discovered with certainty only in graphic records taken from the heart. It leads to no disturbance of the beats which is evident during ordinary clinical examination. Yet we cannot afford to neglect it. It is a frequent sign in heart disease; it may be a forerunner of grave disturbances of the heart's mechanism, which will be spoken of later; it is in itself always serious. The length of the *P-R* interval is one of the important prognostic signs in mitral stenosis, for such hearts when regularly exhibiting prolongation of the interval are hard hit, and the damage is not necessarily confined to the auriculo-ventricular bundle, but is usually disseminated throughout the heart muscle. A prolongation of the *P-R* interval is not at all an infrequent sign during the course of acute infections, especially those of rheumatic type. It may be that a patient who exhibits some slight enlargement of the heart, or in whom a systolic murmur of rheumatic origin is present, develops a sore throat or slight febrile attack or soreness of the joints. At the same time prolongation of the interval may be noticed. It may even occur apart from other manifestations of infection. Whenever it develops it is a sign of considerable consequence, for it indicates involvement of the heart muscle. Clinical medicine has recognized lesions of the heart valves for many years; it has looked almost in vain for signs of early muscle damage. Advanced rheumatic disease of the heart has essentially a long history behind it; it probably results from repeated infection and repeated slight damage of the valves and muscle. Transitory prolongation of the interval between auricular and ventricular contractions is one of the very few signs which we possess of these invasions. The greater part of the ventricular musculature may be spoken of as silent, in the same sense that large areas of the cerebral substance are termed silent. The auriculo-ventricular bundle, like the pyramidal tracts of the spinal cord, gives, when damaged, early indications of such damage, though the lesion may not be, and usually is not, confined to it. The electro-cardiogram thus serves an extremely useful purpose, for it not only gives us an accurate index of the manner in which the functions of the auriculo-ventricular bundle are fulfilled, but it also throws light upon the condition of the myocardium as a whole. A single manifestation of bundle deficiency is spoken of at the present time: others will be noted at a later stage.

Lesions of the Bundle Branches.

The auriculo-ventricular bundle divides into two large branches near the ventricular septum and these run and arborize under the endocardium before joining the muscle of the ventricle. Just as lesions of the main stem of the bundle give rise to electro-cardiographic signs, so do lesions of its branches; and a number of such lesions may be recognized to-day, and their significance may be appreciated. A lesion of a bundle branch results, not in a prolongation of the conduction interval, but in profound modification of the manner in which the auricular impulse is distributed to the ventricle through the conducting system as a whole; the result is a profound modification of the type of electric curve which represents ventricular contraction, for the type of electric curve is chiefly dependent upon the point or points at which contraction starts in the muscle from which it is recorded.

* Working the tenure of a Beit Memorial Fellowship.

If there is a lesion, let us say, of the main division of the bundle which runs to the right ventricle, the auricular impulse, instead of travelling to both ventricles and starting contractions in them almost simultaneously, runs to the left ventricle alone; the contraction consequently

Fig. 8.—An electro-cardiogram from lead III, from a patient who had heart enlargement. The auricles (P) are beating regularly; each auricular contraction is followed by a ventricular beat of anomalous form, at an increased interval. The P-R interval is increased to 0.21 second, indicating damage of the main bundle. The shape of the ventricular portions of the curve indicates that the right bundle branch has also been damaged and no longer conducts. The impulse from the auricle is consequently conducted to the ventricle along the left strand only. As a result the contraction reaches the ventricles and starts the contraction in them in an abnormal manner. The normal electro-cardiogram results when the contraction spreads from both sides almost simultaneously. This form of abnormal curve results, as shown by experiment, when the contraction spreads to both ventricles from the left side.

starts on this side of the heart, and spreads in an abnormal manner throughout the chambers. The result is an electro-cardiogram of a definite but abnormal shape. A curve of this sort is shown in Fig. 8.

Following upon each auricular contraction (P) is the representative of the ventricular contraction; it consists of a small upward peak, a deep depression of long duration, a short almost horizontal line and a rounded summit, not dissimilar to P. The type of curve is well known, and is only produced in the manner described.

Damage of the main divisions of the bundle is not at all uncommon, and is usually the result of fibrosis. Electro-cardiographic examination alone will reveal such lesions; the single example which I have given is sufficient to illustrate the manner in which they may be diagnosed.

It has been said that prolongation of the P-R interval is usually accompanied by more or less widespread muscle change. So also are the curves which indicate damage of a bundle branch. The two signs are not uncommonly found in the

Fig. 9.—An electro-cardiogram from a case of congenital heart disease, illustrating a single point, namely, the exaggeration in the amplitude of deflections which often occurs in this condition.

Curves in Congenital Heart Disease.

Electro-cardiography reveals many other changes in the shapes of ventricular curves in hearts beating regularly and at normal rates, and a number of them are of

practical significance. I have already referred to the types of curve which are found in mitral stenosis. It will suffice if I give a single additional illustration. In my first article I spoke of standardization of curves, and it is known that the height of the greatest peak in normal curves rarely exceeds 10 or 15 scale divisions. In congenital heart disease values of 25 or even 30 scale divisions are not at all uncommon (Fig. 9) and sometimes values of 45 and more are found; such exaggerations are consequently of value in the recognition of these malformations.

The Nature of Bradycardia as Portrayed by Electro-cardiograms.

When the pulse-rate is slow its slowness may be due, as is well known, to one of two causes. The ventricular rate may be retarded, or a number of the heart-beats may fail to reach the wrist. The last condition will be dealt with more fully at a later stage. The first, or "bradycardia" (a term generally used for slow action of the ventricle), is not, as was formerly thought, a simple condition. It may result from slow action of the heart as a whole, or from deficiency in the conduction of impulses as they travel through the heart from its upper to its lower chambers; and the two states must be carefully distinguished, for, as the life-histories of such hearts are different, so the prognosis and treatment are different. Electro-cardiograms readily distinguish between them.

The ventricular beats are seen in both, and they occur at similar and widely spaced intervals (Figs. 10a and 10b);

Fig. 10a.—An electro-cardiogram from an athlete who exhibited bradycardia. The pulse and ventricular rate were 35 per minute. In the figure each cycle consists of the usual auricular and ventricular summits. The whole heart is shown to have been involved in the slowing.

Fig. 10b.—An electro-cardiogram from a patient who exhibited bradycardia of a different form. The pulse and ventricular rate were 20 per minute. The ventricular beats are seen in the curve; they are represented by deflections R, S and T, and are placed regularly. In addition, a number of auricular summits, P, are seen; they are placed quite regularly in the curve, but fall with varying relations to the ventricular curves. There are two independent rhythms; one, auricular, at the rate of 77; and the other, ventricular, at a rate of 30. The condition is spoken of as complete heart-block, and results from discontinuity of the auriculo-ventricular bundle.

but while in slowing of the whole heart a single auricular summit P precedes each ventricular contraction (Fig. 10a), where there is deficient conduction many such auricular summits are found, and they may fall, as in Fig. 10b, with varying relations to ventricular systoles. Two rhythms are established, the one auricular, the other ventricular; each is regular and independent of the other. This is the condition, spoken of as complete heart-block or complete dissociation, which is so often associated with attacks of loss of consciousness (Stokes-Adams syndrome). It is the last stage in the series of phenomena which result from damage to the auriculo-ventricular bundle, and results from grave impairment of this tract, so that no auricular impulses are conducted to the ventricle. If a patient has a ventricular rate of 30, 40, or 50, we are no longer satisfied in describing his symptom as "bradycardia"; a further analysis of the nature of the heart's mechanism, to determine the cause of the slow ventricular action, is essential before we can foretell the future history of the heart or suggest those measures which are best calculated to prolong its action.

The Nature of Regular Tachycardia as Portrayed by Electro-cardiograms.

When the pulse and ventricular beats are regular and rapid, the acceleration may often be ascribed to fever, infection, poisoning, or some specific disease such as exophthalmic goitre. But there is a large class of patients

in which the causation of tachycardia is by no means easy to determine by ordinary clinical means.

A number of patients, who are in reality sufferers from paroxysmal tachycardia, come under observation during the attacks (which may have a duration of a few hours or many months) and the true condition readily escapes detection; a number have *persistent* tachycardia of cardiac origin. The tachycardia, whether paroxysmal or persistent, may be from 120 to 300 in rate. Electro-

Fig. 11.—An electro-cardiogram showing tachycardia in exophthalmic goitre. The rate is 150 per minute. In this instance the heart beats have started in the usual situation, the junction of the superior vena cava and auricle, as evidenced by the normal shape of *P*. The ventricle (*R, T*) has responded to each auricular beat. It is an example of a tachycardia which has arisen as a result of altered innervation or altered nutrition of the normal pace-maker.

cardiography is especially valuable in such cases. When the heart is accelerated as a result of fever, poisoning, or exertion, the general form of the electro-cardiogram is retained. The summits corresponding to the auricular and ventricular contractions are clearly visible (Fig. 11) and are of normal outline. But in the special group of heart cases to which I refer such is not the case. It is customary to find either that the auricular summit has vanished or is obscure (first half of Fig. 14) or that it is inverted (Fig. 12).

Fig. 12.—An electro-cardiogram taken during a paroxysm of tachycardia. The rate is 132 per minute. The tachycardia has arisen from an abnormal auricular focus, which is known from the inversion of *P*. Each auricular contraction gives rise to a ventricular response (*R, T*).

These signs are invaluable, for they immediately acquaint us with a pathological fact which has only recently been discovered, namely, that the site of origin of the heart-beat may suffer displacement.* The normal heart-beat is now known to start in the region of the union of the superior vena cava and the right auricle. The abnormal or dislocated rhythms may start at several other points, for example, near the coronary sinus. The absence of auricular summit or its inversion is a sign of the awakening of new impulses in a portion of the heart muscle at some distance from the normal starting point, and the tachycardias with which such signs are associated are known to belong to a specific and essentially cardiac group; they run their own special courses. Such tachycardias react to rest, drugs, and other agencies in a manner quite their own. Thus, where tachycardia exists, electro-cardiography is not only a valuable aid in diagnosis, but is also most helpful in guiding treatment.

Amongst the tachycardias of elderly subjects one form exists which is of special interest. The pulse-rate and the rate of beat at the apex may be 120 or perhaps 150. The rate persists and the cause is not determined. Electro-cardiography reveals the unexpected fact that the true rate of heart-

beat is much greater, for while the ventricle beats at 120 or 150 the auricular rate is 240 or 300 (Fig. 13). The type is of importance not only because it has its own peculiar prognostic features, but also because it reacts in a special manner to drugs of the digitalis group. Often, by suitable treatment, the normal heart action may be restored. These cases are not uncommon. I have seen an instance of a similar kind in which, while the auricles beat at 300 per minute, the ventricles beat at 75, or exactly

Fig. 13.—An electro-cardiogram from an elderly patient with persistent tachycardia. The ventricle (*D*) is beating at 159 per minute. Before each ventricular summit *R* is an inverted auricular deflection *P'*; another *P* deflection is seen in the usual position of *T*, the latter being inconspicuous. The series of *P* deflections occur at regular intervals throughout the curve. The rate is 318 per minute, or exactly twice that of the ventricle. The auricular beats have arisen in an abnormal focus, as evidenced by the form (inverted) of their electric curves.

a quarter of the auricular rate; the rapidity of the auricular action could not be determined in this patient who had a normal pulse-rate by any other means than electro-cardiography.

One of the great lessons which graphic records have taught is the fallacy of judging heart-rate by pulse-rate, or even by the rate of beating of the heart's apex. If a man's pulse is said to beat at 100 per minute, the statement awakens an impression which is governed largely by experience of the reaction of heart-rate to fever, infections and other common causes of altered rate. Judged from this point of view, conclusions drawn from an observation of the pulse-rate are only valid if the pulse is a true guide to the rate at which the heart beats are generated at their normal starting point. It is obvious that conceptions based upon actual pulse-rate are erroneous when apex and pulse fail to agree; the rate of one may be double the other. But the rate of apex beat is often equally deceptive. When we wish to arrive at a conception of actual heart-rate, and of its increase or decrease in response to chemical or nervous influences, it is important that our thoughts should carry us, not to the ventricle, but to the actual starting point of the rhythm. Auricular and ventricular rates may not correspond. And it is equally important, as shown by actual practice, that we should fully avail ourselves of our means of determining the actual site of origin of the heart beats in the individual case; for if, as often happens, the seat of impulse formation has been displaced, none of those rules which customarily guide us in judging of its rate and its reactions are longer applicable. I may illustrate these contentions by referring to the special type of tachycardia exhibited by elderly people. The ventricular rate is usually but

Fig. 14.—An electro-cardiogram and brachial pulse curve from a patient who was the subject of paroxysms of tachycardia. The figure shows the end of a paroxysm; the tachycardia (rate 127) terminates abruptly, and after a pause the normal rhythm is resumed (rate 72). The normal rhythm to the right is represented by the auricular summit *P* and ventricular deflections *R, S* and *T*. The tachycardia is represented to the left by ventricular beats, *R, S* and *T*, of the same form; this shows that the tachycardia has arisen above the ventricle, for the impulses have coursed along the normal ventricular channels. The auricular beats are represented obscurely. They are inverted, and fall upon the *T* deflections, slightly deforming all but the last beat of the paroxysm. The paroxysm has arisen in an abnormal auricular focus.

half the full and true heart-rate. Again, the normal heart-rate is influenced in many ways, notably by posture. The rate falls when the subject passes from the upright to the supine posture. In the tachycardia of which I speak that is not the case; the rate is maintained in all positions; and if there is a fall of auricular rate in such a subject, the

* That they signify displacement of the "pace-maker" is known from experimental observations.

fall is not gradual, as in that of the accelerated normal rhythm; it is abrupt, as is the fall in all tachycardias which have abnormal starting points; the change occurs with one heart-beat; the fall comes when the new rhythm vanishes and the old rhythm is resumed (Fig. 14).

The necessity for a clear analysis of the heart action may be further illustrated by the same group of cases. We are dealing perhaps with a case in which auricle and ventricle are beating regularly at 240 and 120 respectively. Alternate auricular impulses alone reach the ventricle and stimulate its contraction. Suppose that this patient is placed upon digitalis. When the drug is administered the pulse is 120 and regular. Digitalis, by increasing the grade of block, may reduce this pulse-rate to 60; under these circumstances it does not reduce the auricular rate, which remains at 240; but it further impedes transmission, so that whereas one impulse in two originally awakened ventricular response, after its administration one impulse in four finds a passage. Thus, though the pulse-rate has reached normal limits, the true heart-rate is as it was before. But before the ratio 240 : 60 (or 4 : 1) is established, the heart passes through a transitional period, during which cycles of 2 : 1 and 4 : 1 ratios are mixed, and the pulse therefore becomes very irregular. *The development of this irregularity*, when the pulse-rate falls from 120 to 100 or 80 and while the patient is upon digitalis, *is a favourable sign*, for it is an indication that the heart is reacting to the drug, and a further fall of pulse-rate and a return to the regular state may be predicted with some confidence if the drug is continued or its dosage increased.

Paradoxical as this conclusion may seem at first sight, and untenable as it would appear were the analysis of irregularities impossible, it is none the less true. It serves to illustrate that conclusions which apply to one form of heart action do not apply to another, and emphasizes the necessity that the mechanism of the beat should receive thorough investigation.

(To be continued.)

Memoranda :

MEDICAL, SURGICAL, OBSTETRICAL.

A NOTE ON "GRANULE-SHEDDING" IN TREPONEMA PERTENUE.

SEVERAL examinations of the spirochaete of yaws have been made here by the dark ground illumination. The spirochaete is of very delicate character, and varies in length from two to three diameters of a red blood corpuscle. In the majority of instances small spherical highly refractile "granules" are present—usually terminal—one at either end; others may be seen in the course of the spirals, but these gradually gravitate towards a pole.

After prolonged observation extrusion of these granules was observed.

This spirochaete does not show the "corkscrew" action of *T. pallidum*, nor is there any translation across the field. It exhibits, however, a lateral vibratory movement, and, presumably by means of this, the "granule" is shot with some force from the body of the spirochaete into the surrounding medium. Immediately after extrusion it is stationary, but soon it begins to make its way through the surrounding fluid, apparently turning over and over on itself. Motility is distinct, but I have not seen any suggestion of a flagellum.

The extrusion of this "infective granule" is a very striking phenomenon, and its occurrence in yaws may be of interest, following, as it does, on the work of Balfour¹ on syphilis and spirochaetosis of Sudanese fowls, and his observation on "granule-shedding" in these conditions.

H. S. RANKEN,

Yei, Lado Enclave, Sudan.

Lieut. R.A.M.C., attached E.A.

NOTE ON THE OCCURRENCE OF A SPIROCHAETE IN CIRCOPITHECUS RUBER.

IN the course of examination, by dark ground illumination, of the blood of a *Circopithecus ruber*, experimentally

infected with *Trypanosoma gambiense*, a spirochaete was observed.

This spirochaete was short and thick—roughly 8 to 12 μ in length—and showed active movement and progression across the field. Spherical terminal refractile dots were present, but extrusion of granules was not observed.

Castellani and Chalmers² describe *S. macaci*, and *S. pitheci* was observed by Thiroux and Dufougere³ in *Circopithecus patas* in Senegal.

This monkey was captured in the Lado Enclave, Sudan.

H. S. RANKEN,

Yei, Lado Enclave, Sudan.

Lieut. R.A.M.C., attached E.A.

Reports of Societies.

EDINBURGH OBSTETRICAL SOCIETY.

Wednesday, June 12th, 1912.

Dr. HAIG FERGUSON, President, in the Chair.

Axial Rotation of the Myomatous Uterus.

PROFESSOR KYNOCH, in a communication on this subject, recorded the case of an unmarried woman, aged 56 years, who had been aware of an abdominal tumour for twelve years. A month before admission to hospital she had been suddenly seized with acute pain, retention of urine, and extreme constipation. The abdomen was the size of a seven months pregnancy, and the condition resembled a concealed uterine haemorrhage. At operation the tumour was found to be dark purple in colour from haemorrhage into its substance, and the cervix formed an elongated pedicle as thick as a finger, with two and a half twists from left to right. The fibroid grew from the top of the uterus. The tubes and ovaries participated in the torsion. It was suggested that pain associated with a fibroid might, more frequently than was supposed, be due to a slight degree of torsion.

Dr. BARBOUR asked if the dark colour was due to actual haemorrhage into the substance of the tumour or to transudation of blood pigment, as occurred in necrobiosis.

Dr. HAULTAIN inclined to the opinion that the specimen was an example of necrobiosis. In a case reported by him two years ago the cervix did not form a pedicle, but the whole organ was twisted.

Dr. FORDYCE said that on section of some fibroids vessels were seen, which might give rise to considerable haemorrhage. The specimen looked like a marked example of necrobiosis. That form of degeneration frequently occurred during pregnancy and the puerperium.

The PRESIDENT asked if the specimen was as dark at the time of removal. He had never seen such severe symptoms in axial rotation. He mentioned a case in which he had removed during pregnancy a twisted subperitoneal fibroid showing necrobiotic changes.

Professor KYNOCH said he appreciated the resemblance to red degeneration of a fibroid, but the specimen was almost black on removal, the cut surface was uniformly dark, and blood oozed from it.

Ectopic Gestation: Difficulty of Diagnosis.

Dr. F. W. N. HAULTAIN read notes on two cases of ectopic gestation in which the diagnosis was difficult. In the first the patient, 25 years of age, had had one child five years previously. In the second pregnancy her doctor had diagnosed a sacculated retroverted uterus. The fetal head was felt at the top of the tumour, 2 in. above the umbilicus. No symptoms had occurred except severe pains on two separate days, and then fetal movements stopped. As her pulse-rate and temperature were high, two gum-elastic bougies were introduced to induce labour. They went in for a distance of 8 in., and could be felt near the apex of the swelling. Labour pains started four days later, but the uterus was found to be empty. When the abdomen was opened the sac was found closely adherent to the intestine; inside it was a fetus 3 lb. 9 oz. in weight. The uterus was pulled high up by the sac, the increase in length to 7 in. being mainly due to elongation of the lower uterine segment. In it lay a semi-detached cast. In the second case the patient was married in October, 1910, and two months later, after one week's amenorrhoea,

¹ Balfour: BRITISH MEDICAL JOURNAL, May, 1911. Fourth Report Wellcome Tropical Research Laboratories, 1911.

² Castellani and Chalmers: *Manual of Tropical Medicine*.

³ Thiroux and Dufougere: *Bulletin Soc. Path. Exotique*.