Thesis for M.D.

The Sphygmograph, its clinical value in pharmacology & disease, with special reference to diseases of the vascular system.

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The Physiograph

Its clinical value in pharmacology and disease, with special reference to diseases of the vascular system.

The simplest form of instrument which for measuring the movements of the heart is that described by Harvey (on page 83) in his well-known work "De Circulatione in Anim". He describes the apparatus as follows: "Let there be two ampullae A B fixed to the extremities of a hollow, flexible tube the whole being closed at both ends. If we apply pressure at A, an impulsion is propagated to B, which reaching a horse fastened to it, induces by its vibration that the ampulla A is compressed, the same manner when the compression ceases the horse falls. If the compression received at A be sudden or slow, short or protracted, the oscillations of the horse faithfully trace on a cylinder the character of the movement. If we have three systems similar to the above, applying one after another in the ventricle A a third at the apex of the heart we get faithful traces of each of the vibrations. By means of these monometric ampullae Harvey was able to obtain the following tracings.

Shortly after this Herion constructed a little instrument for recording the movements of the pulvinar. This instrument was filled with mercury, but it was not of much use owing to the rapidity of its movements.

Microscopes having noticed that when one leg is crossed over the other, the upper leg moved at each inspiration
constructed a sphygno-graph which combined the ideas of King & Ludwig. The first instrument of Ludwig was called the Rynograph. It consists of a W shaped apparatus containing Mercury, to this was a spring attached which recorded all the movements of the mercury. Gaging to the Mercury oscillating for some time after it is set in motion by the fluid (as it was called) a different instrument known as the Febry-hygrograph. This one though more precise than the former was also faulty.

Fig 106. MMM (Going by Cirodte's sphygno-graph.)

We see that Cirodte's instrument only recorded the principal beats of the heart without any subsidiary waves. The cause of this is due to the motion of the instrument, the lower being suddenly raised, falls suddenly also owing to its weight.

Merry improved upon this instrument by employing a light lever which is raised & dropped by a vertical rod attached to a rounded spring. This spring rest on the acty & is moved at each pulsation of it. The lever rising & falling upon smooth engraved paper (which is moved by a clock-work arrangement) the pulsations of the acty. These tracing are very different from those taken by Cirodte's apparatus.

The sphygno-graph which I have used in private practice is Hendley's. The advantage it possesses over Merry's are (a) its size which makes it to be easily carried about in private practice (b) simplicity of the (c) it is easily guarded as (d) it is more readily adjusted to the arm than Merry's.

The heart

consists of a right & a left side each side containing two chambers an auricle & an atrium. Merry & Shannon conclusively proved that these two sides were simultaneous in their action by passing sounds into the right.
anulus, right auricle, left auricle respectively. They found that the tracings performed in this way favored the left auricle over the right. As a result of this syndrome, when the jugular veins were seen to close, a single beat of the heart was no longer visible. When the tracings were taken from the right ventricle, we again only heard one sound.

The heart contains within its walls ganglia for its automatic movement. Three are fixed (at the base of the heart, at the entrance into the right ventricle), Richards (in the thickness of the auricles-ventricle groups). The apex of the heart does not contain any. (Rutshnold) By catheterization of the apex away from the rest of the heart, it can be seen that while the remainder goes on beating, if a ligature is placed tightly at the level of Pernamuk's ganglion, the heart entirely ceases beating. If another ligature be placed at the base of the auricles-ventricular groups, the heart of the heart becomes re-established. From this experiment it comes to the conclusion that Pernamuk's ganglion provided over the aorta of the heart while Ludwig's ganglia provided outside. This has been doubted by many physiologists.

When we apply the ear or the stethoscope to the posterior of the upper right in the natural condition two sounds are heard. One is heard loudest over the entire auricle when the heart is small. But when heard through the chest wall it is loudest at the apex of the heart, this usually corresponding to the intercostal space a little to the apical line of the middle. It is louder because it is at this point that the apex becomes superficial. The 2nd sound has its seat of maximum intensity in the 2nd left intercostal space in the 3rd right intercostal space immediately to the side of sternum. Many pathological physiological conditions affect the hearing of these sounds. The cause of the first sound is due to the closure of the
annulus ventricular valves during the ventricular systole falls to the tension of the muscular fibres of the ventricle. This is the reason why the limits are different in time from each other. The 2nd sound is due to the stretching of the sigmoid valves which open during the ventricular diastole when the blood which has entered the ventricle goes up. Visc-a-tergo tends to flow back into the ventricle thus closing the sigmoid valves.

Many highly in a perfectly healthy condition have auscultation of the heart sounds. This auscultation is due to one set of valves being closed before the other. In the case of the aorta, it is due to the arterial pressure being greater than the pressure in the pulmonary vein, the respiratory movements confirm this statement.

Sohn Hunter was the first to demonstrate the contractility of arteries. He showed that if he removed an artery of a rabbit which had died of death by sudden haemorrhage the caliber of the artery was very small. He observed that its contractility was very feeble in the great arteries but became more pronounced the further the vessels are from the heart and most marked in the capillaries. The cause of this is that the larger arteries contain more elastic tissue than the smaller whereas the latter contain more fibrous tissue. For this fibrous tissue is provided not by vasomotor but vasodilatory nerves, inactivity and dilatation are more pronounced among them than in the larger vessels. When the arteries are contracted the arterial tension is raised because the blood sent from the heart is prevented from passage through the arteries by the contracted condition of the capillaries. This also when the arteries are dilated the blood escapes more quickly through them so the tension falls.

The Pulse is due to the blood being driven along the course of an artery partially by the heart partially by the contracture of the artery itself. As the chief repercussive force is derived
from the heart, the tracing of the pulse indicates very closely the force of the heart. The condition of its valves, if the arterial walls be athromatous, they are here intrinsically
when in the normal condition. When to a varying extent modifies the exact pulse waves which we ought to find on the tracing. In the normal pulse we get the tracing similar to (Fig 1)
and pulsation

Fig. 1 Normal tracing. The line of ascent defines when the suddenness or slowness of the Ventricular contraction. If sudden the line of ascent will be almost vertical; if slow it will be more or less oblique. The ascent may not only be vertical or oblique but may also be jerking. This condition of the pulse we get in acute degeneration and also in arterio-femoral we very frequently from it in an aortic regurgitation. In the former this case it is due to the loss of elasticity in the arterial coat, due to the blood falling back upon the incompetent aortic valves. The summit of a pulse tracing may also vary. It may be flat, its ratio of outflow to inflow is 1:1, or it may be rising, which indicates the inflow greater than the outflow. A short, quick upsweep indicates that the outflow is greater than the inflow. (Fig 5)

The line of descent does not as some suppose indicate the diabetic of the heart but only a part of the line that passes is that part which follows the aortic notes indicating the course of the aortic waves which carry

to the diastole of the heart. In the descending line of the normal pulse we see two curves. (Fig 1) The first is called the first "diastolic" the second "diastolic". The latter is always
increased by feeble arterial tension. Whenever the number of capillaries opened is increased, by hemorrhage, fever etc., the arterial tension becomes lowered. The diastolic sound becomes well marked. You were when the arterial tension is high, the heart beats slowly; the diastolic sound is not so well marked.

Having now described the various forms of phonography which have been used, the different parts of a normal pulse tracing, I shall now give some examples of tracings which I took by means of Faradie's phonography, from patients suffering from various complaints. Some of these tracings were taken by myself while I was domiciliary, some were taken at different places where I was, from "long term" during the summer of 1886, for a few of the latter cases I was unable to follow the disease to its termination as I had to leave the place. The majority of the cases of auscultation were taken by me from patients in the Royal Infirmary, Edinburgh during the autumn of last year. All the other occur in private practice.

The first case is one of Asthma.

The patient was 31 years of age and had suffered from asthma all his life. He was smaller than the average height, thin and emaciated; he had a dry harsh cough, no wheezing notes were heard all over the chest which changed about from one place to another; more especially were they heard down the anterior border of right lobe. All the extraordinary muscles of respiration were brought into play and the dyspnoea was very pronounced.

The above tracing was taken during the attack. The respiratory line is evident; the tension is well sustained.
the "systolic" and "diastolic" waves are well marked. As previously stated, this wave indicates the closure of the aortic valves by the backward pressure of blood into the aorta, while the "diastolic" wave indicates the termination of the systole of the heart and is thus seen to be prolonged. The pulse is very irregular and slightly thready.

Fig. 7 was taken three hours after taking 200 of 17% lobelia. It looks more intense than usual. The dyspnea was much less. The felt much better than previously. The pulse is more regular. The wave between the "systolic" and "diastolic" waves is still well marked, the pulse is also good, and the pulse is not so thready.

Fig. 8 taken on the following day after Fig. 7. There was nothing in the blood to make the pulse less marked. The respirator is still well marked, pulse slightly irregular. We say that during inspiration the heart beats more strongly than during inspiration, this being indicated by the higher ascending stroke. As the asthma returned on the following day more marked by the 4th day I gave him 200 of 17% lobelia. This at first seemed to have a wonderful influence over the dyspnea, it almost entirely disappearing after the second dose. The pulse is regular and the diastolic wave is well marked.

The respiratory wave is not present. The pulse is shown by the arterial trace by paralysis of the vaso motor nerves, thus increasing the dilatation. This is shown by the rapidly descending line of the well marked diastolic. Prof. Forrer in a clinical lecture on asthma which I had the pleasure of hearing at the beginning of the winter session said...
that asthma must likely be caused by spasm or contract of the arterioles of the lung. It was relieved either by
injection of Amyl or Nitric Oxide, the dyspnoea passing
away in the former case in about 40 seconds and in the
latter in about 90 seconds. Belladonna must probably
act in the same way as well as all the other anti-
spasmatics.

About 10 days after the last tracing, the patient had
another attack of asthma. Fig 10 was taken. The respiratory
line is very
well marked
early in the
diastolic wave. The pulse is rather quick, the tension good. He was
given 3/4 of % Anaphetidin. This had the effect of allowing
him to get
some sleep.

Fig 11 was
taken while he was taking the anaphetidin. This relief
reflects
Fig 11 after % anaphetidin. His relief reflects

Fig 12 is after
he had fin-
ished the
anaphetidin. The respiratory line is about the diastolic wave
is well marked. Tension is good. As I left Yorkshire
shortly afterwards I was unable to continue any ob-
servations on this patient. In the normal pulse type
respiration has little effect, but in some illnesses the
respiratory line is well marked, chiefly in those cases
where there is some obstruction to respiration. We
shall see some alteration due to respiration in
anemia of the artery.
Tubercular Meningitis & Tubercular Meningitis

Sept. 4th

Fig. 13

Chills very high.

Tubercular patient

The respiratory waves are not well marked. Toward the end of the tracing we see the effect of a cough upon the

Fig. 14

Pulse is 87

slow regular

Tracing is very high as shown by the blunt apex of the

Fig. 15

shows a pulse tracing with

Fig. 15, later still
days after fig. 14. The pulse is regular, tension not so great as in others, the presystolic & diastolic waves are very indistinct. Borst. very little more exsudation great, tongue red & moist, conjunctivae very red, no yellow film or meniscus, no catarrh in eyes, no exudation. She is very thirsty, drinks much every day. A leech was applied to temple & pit of temporal area, about one ounce of blood, after which the pain in head was a little easier.

Sept. 11th.

Fig. 16: Cheerful, appetite good, quick 108, not constipated, no expectoration of mucus or blood, no excitations, no squinting, no headache, no colicky pain, no diarrhea. The pulse is regular, tension not so great as in others. The presystolic & diastolic waves are very indistinct. Borst. very little more exsudation great, tongue red & moist, conjunctivae very red, no yellow film or meniscus, no catarrh in eyes, no exudation. She is very thirsty, drinks much every day. A leech was applied to temple & pit of temporal area, about one ounce of blood, after which the pain in head was a little easier.

Fig. 17: The days before death of pain, but his respiration was in a stridulous condition. Only under stood when spoken to loudly. Tongue swollen & coated with a coating, no bubbles, no exudation. The diastolic waves distinct, the tracing shows through imperfectly (going to the menses of the patient) the respiratory line. The tracing is very similar to Fig. 166 in Murray's paralysis of the brain. Taken from the left renal vein. The patient gradually became weaker & died two days after above tracing.

Abortion

Fig. 17 after abortion of a woman, who had an easy abortion, very little loss of blood. The abortion took place about the 3rd month. The tension was high, the pulse action slow & regular.

Fig. 18 from the same woman after taking 6 of quinine. Borst. the pulse is very high, pulse slow regular. The tracing shows a sharp pointed apex immediately following the loss of blood. There is a well marked presystolic wave, which indicates a very contracted state.
The pulse is regular below productive &
distractive waves very well marked, tone

Fig. 19. - after E. C. Hope.

Fig. 20. - Epilepsy.

Fig. 20. was taken 16 hours after the fit.
The tone is high, pulse somewhat tremulous,
the productive wave is very well marked,
the dyspnoe is plainly felt but is not
as well marked as the other.
of the arteries respirating the free exit of blood from the arteries.

Fig. 19. A case of asthma.

Mr. W. visited the patient at the 2nd month. The past three years were very sad. She was given 10 gr of phreny glycer. This tracing was taken after she had had 5 gr. The pulse is tremendously tenacious not nearly as high as in last tracing, the diastolic & diastolic waves inaudible.

**Epilepsy**

Fig. 20. shows a pulse tracing taken from a man in one hour after an epileptic fit. The pulse tracing has nothing abnormal; the tension is fairly well sustained, the precordial & diastolic waves are fairly distinct. The pulse is regular but faint. He has never had a fit before.

He is a short stout man of heavy build; has an agitated history, there were no prominent symptoms. On his fall his clavicle was fractured.

Fig. 21. shows a tracing taken two days after the fit. The tracing is not much different from the diastolic curve is very well marked as also is the diastolic curve. The pulse is slower than in fig. 20, it is regular & the tension is fairly well sustained.

**Fracture of the Skull**

Fig. 22. shows a tracing taken from a man who had been injured at the North Bridge Works by a fall falling on his head causing a compound comminuted fracture.
When brought into the Hospital he was quite unconscious, and rational. The fracture was at the Posterior Spur or angle of the right Parietal bone. When the finger was pushed into the fracture so as to cause pressure on the brain, the loudness became increased. Investigation was done at 4.30, and tracing was taken that same night. The amplitude of the pulse is high owing to the stronger action of the heart, the tension is very good, the precordial wave is not well marked but the diastolic (or aortic) wave is very distinct. There is nothing abnormal in this tracing with the patient recumbent without a single bed symptom.

Fig. 23 shows the left radial, the amplitude of which is much less than that of the right. This may be due to the right arm being used more than the left and consequently having larger arteries or it may be due to an abnormal division of the brachial artery.

Hemiplegia

This is a very interesting case of right sided hemiplegia. The patient had a slight aphasia fit on Aug 25th. She had a previous attack 2 months ago. Sensation was normal on both sides. Right hand was more paralysed, right leg was weaker (parous) than left. There was tinnitus of check on right side indistinct speech, spasm of tongue in unusual time. The eyes close perfectly.

Fig. 24 shows a tracing taken from the non-affected side and Fig. 25 from the paralyzed side both taken during the same unit. Fig. 26 shows very high tension. There was also an example of an other anomaly. Her age was 58. The precordial & diastolic waves are only
slightly marked. Fig. 25 taken from the paralysed side shows a slow tension, the pulse is sharp pointed and almost immediately followed by a distinctly sharp pointed presystolic wave. Then follow the diastolic wave and this is followed by a sharp pulse, but the systolic tension is due to the slow motor waves taking the general pulse of that side of the body as a consequence of this the presystolic wave is much more prominent than usual. The presystolic wave being due to the oscillatory movement of the walls of the artery is increased when the vessels are dilated because the inertia of the wall is much greater in a dilated vessel than in a contracted one.

Fig. 26 shows a lowered tension on the unaffected side. The presystolic and systolic waves are present, the pulse itself appears normal. Localization of right arm hand is lost but is present in foot leg.

Fig. 27 the time is long but the amplitude of the pulse is high, the presystolic wave is again suggested and numerous oscillations are present in the descending line due to the inertia of the walls of the dilated artery. Fig. 25 is slightly different from fig. 27. Fig. 27 taken from the paralysed side. This is most likely due to the Barre-Hebert paralysis not being complete on the previous day.

Fig. 25 shows that the tension is still getting less. As a rule the unaffected side usually becomes weaker though not to the extent of the paralysed side. They tried a number of patients with the dynamometer and found that the non-paralysed hand could squeeze about five times stronger than the paralysed side. But that the non-paralysed side is not much weaker than usual.
The ratio which I have in paralyzed side pressure 4.6 lb., non-paralyzed 19 Hb., also paralyzed side pressure 7 lb., non-paralyzed 37 Hb.

Fig. 29 shows a tracing taken from the paralyzed side. The amplitude is not so great here as in Fig. 27, the periodic wave is still very distinct. There is not very much difference between the two taken from the unaffected side.

Fig. 30, Aug. 15th, shows the first tracing taken at the same time for the paralyzed side. It is almost similar to Fig. 29. There is not a very marked difference between it and Fig. 30. These tracings clearly indicate that there is paralysis of one of the motor nerves of the paralyzed weakened side as well as of the muscle of the same side. Often a patient can see the paralyzed limb a little if he makes a very strong effort at the same time with the unaffected limb. The coordinating center in some way affords to act for both sides by stimulating some center in the medulla oblongata.

In connection with this subject of Hemiplegia (which is only a symptom of a disease) we might always find out if possibly the cause. The chief cause are thrombosis, embolism, hemorrhage. For a correct diagnosis it is absolutely essential to pay attention to the vascular system. If pulse be very hard, tension high, heart hypertrophied most probably the paralysis is due to hemorrhage or embolism, but when the pulse is low, irregular, heart weak & dilated
my conclusion present the diagnosis lies between haemorrhage or thrombosis. If loss of consciousness is large in extent likely it is due to thrombosis. If loss of consciousness is small it is due most likely to haemorrhage. Both meet without any symptom could indicate that the haemorrhage was a vascular lesion. In this case the lesion is not very large. There is no loss of consciousness, but ataxia is present. So the haemorrhage is most likely due to thrombosis. Another reason for coming to such a conclusion is that the heart is weak.

Severe Diarrhoea

This patient had profuse diarrhoea amounting to 10 quarts in the legs and an anxious expression of countenance. The diarrhoea began at 3 a.m. and continued until 7 a.m. Collapse was great, pulse imperceptible, tongue dry, referred. She took about the bed 4 hours after the am in the arm.

Fig. 32. Sept. 1st.

This form of pulse is said

Fig. 32. Seven diastolic collapse take always present in children or any other disease which tends to lower the temperature of the body. It can be produced by two conditions: (a) the closing of the arteriole preventing the flow of blood through them; (b) by a small quantity of blood passing through the arteriole. Seven diastolic collapse will give rise to this form. Such a pulse is thought by many to be due to the great amount of serum fluid which passes through the intestines. Probably in this case Mustard plaster was applied to epigastrium. Anemia of half an ounce of blood 37 of 1/4 tsp. of a little warm milk was administered. This had the effect of checking the diarrhoea somewhat the patient

Fig. 33 was taken three hours after

Fig. 32. The sickness & diarrhoea have ceased, tongue is moist now.
right eye remains open while asleep, she complains of great thirst. The vomits have disappeared but she has a peculiar sensation in the legs. There is a great difference between Fig. 32 and Fig. 33. In Fig. 33 the pulse is regular, rather rapid, intensity is pretty good. The fundus of the right eye is visible through not well marked.

Fig. 34 shows a still stronger pulse. The fundus of the right eye is very well marked, but intensity is very well sustained. The feet have acted tense. The patient has virtually no pulse when she is lightly touched, otherwise she feels pretty well.

This case very well illustrates the beneficial effects of a sedative stool in rare cases of diarrhoea. The sphygmograph is very useful here in illustrating the slight improvements which take place in severe cases of diarrhoea or other illness. Such little variations would escape the most delicate tool, and would be impossible without the aid of the sphygmograph to say whether there was an improvement in the strength of the pulse.

Fig. 35 shows another pulse tracing taken from a woman who had suffered for days then weeks, some hours previously but under appropriate treatment she improved much. The tracing is very similar to the last one. Fig. 34, this patient was not so exhausted as the former one was.

It is wish to show that the chief use of the sphygmograph is in connection with diseases of the vascular system. It shall rapidly go over a few tracings which are of little or no importance from a sphygmographsical point of view.

Fig. 36 is from a case of cancer.
of the liver reveals nothing abnormal in the tracing. There is a very distinct diastolic tone, and the systolic tone is also very well marked. This tracing is very similar to many which we see during the frst stage of a running disease.

Fig. 37 is at a later stage, the pulse is quick, regular. There is nothing pathognomonic in such a tracing. Fig. 38 shows a tracing from a case of consumption. It is very similar to the case mentioned above. The heart tones are beating more forcibly, the systolic and diastolic waves are exceedingly distinct.

Ovarian Inflammation

Fig. 39 from a case of ovarian inflammation with edema of the legs. Fig. 39 shows ovarian inflammation. The woman was very short and the heart sounds were clearly transmitted to the surface. The tension is pretty high, the systolic and diastolic waves are distinct, the pulse is rather feeble.

Chorea in the Throat

Fig. 40 from a case of chorea. The pulse is quick, the tension is low. The diastolic wave is not distinct.

Post Partum Haemorrhage

Fig. 41 is from a patient twelve hours after the birth. The patient was pretty severe. Post Partum Haemorrhage, which was checked by the injection of...
(hypostasis) of Donnini's preparation of 6 g. of the hot extract daily. At the time of the hemorrhage the pulse was imperceptible to the touch, since any reason for not taking a tracing at once. Fig. 41 shows a very short print of a very distinct precardiac wave, the aortic notch is well marked. As I have previously stated, the precardiac wave is always well marked if the aortic and arterials are in a state of help. The precardiac wave is not low but this can be explained by the quantity of the arterials which allow a considerable quantity of blood being abstracted from the body without a corresponding difference taking place in the arteries.

Fig. 42, 43, 44, 45 have all been taken from the same patient on successive days. The patient is very well but nothing would persuade her to resume the draft. All the tracings are similar the same of the increased speed of the pulse in Fig. 48 is due to post-mortem the result of the actual death. I was unable to get a tracing from this patient at the beginning owing to the collapsed condition in which she was when I saw her again in the evening reaction had set in. The pulse was very unlike that which we see after a severe hemorrhage.

Acute Nephritis

Fig. 46 is from a case of acute nephritis. The patient was a young man at 21. Face sallow, legs edematous, 3 fr. 4. of un.
10:35 a.m., albumin considerable, some blood corpuscles, and numerous granular, hyaline casts were in the urine.

He got old three weeks ago, experienced headache, or some soreness in the chest (probably a mild attack of Sublet fever). In the 17th his face was swollen, and the following day the left abdomen began to swell, the urine was diminished to 10%.

The uric ear canal was accentuated, and the pulse was 90, the cardiac sounds were normal. The was treated with 5g of Salicylate, and a solution in the morning.

The tension here is very high, the prediostic waves are very distinct, the cardiac motion is rounded and prominent, the descending stroke has numerous secondary waves due to the obstruction to the blood (in this case, in the glomular of the kidneys). This tension is not pathognomonic of nephritis, but is of great use to us as indicating that there is an obstruction somewhere in the valvular system. (Compare fig. 39)

Fig. 47 from a patient suffering from rheumatism.

Act by fig. 47, the patient was brought on by wearing damp clothes in a railway train. The temperature was 101°, pulse 96, the moist tongue, feverish. The tension is high; the pulse is almost fully diastolic. The prediostic wave is barely perceptible. The only special feature in this pulse is the diastolic:

Fig. 48 is after taking 1/4 mg of Aperia in 3/4 hour, showing 3 hours. The tension is greater than in the former tracing. Diastolic is still well marked. The prediostic wave is more visible than in Fig. 47.

Fig. 49 was taken twenty-four hours after injection of Aperia.
after cessation of auricle. The tension line is well marked, of the girth is slow, regular; the amplitude of the pulse is high, the diastolic wave is very distinct, but the presystolic wave is not so prominent. This patient gradually recovered without any cardiac affection, was soon able to go out.

Anœmias

This is one of the diseases in which the sphygmograph is of very great value. There are many cases which are only obtainable at a correct diagnosis by means of the sphygmograph, e.g. when a tumour is situated in the abdominal cavity immediately over or under the heart, & how near one edge of the description in my own practice. The patient had a swelling in the abdomen which fluctuated with each pulse of the heart. Some of the physicians at the London Hospital discharged a tumour; others diagnosed an anœmia. The patient saw Dr. Lawson Tait but he was unable to give a decided opinion. In an exploratory incision being made the swelling was found to be due to a tumour of the pancreas. Unfortunately for the patient Dr. Tait did not consider himself justified in proceeding with the operation.

The chief cause of anœmia is weakness of the arterial wall by increased blood pressure, anything which tends to the degeneration of the arterial wall gives a predisposition to the origin of anœmias, e.g. syphilis, alcohol, rheumatism, fever, &c. Also Bright's Disease. Anœmias may be caused by insufficiency of the blood-pressure. Anœmias are of various kinds & the pulse varying is modified according to the kind of anœmia. The cardiac anœmia does not modify the pulse so much as the pulmonary because it is not in the direct current of the blood stream.

A healthy arterio-attains its full amplitude almost immediately after a ventricular systole but a diseased arterio takes some time to attain its full amplitude.
In attaining this amplitude it is assisted by the small arteries and capillaries. This delay which is caused by the slowly dilating one-arterial resistance is represented on the tracing by a curve in the ascending line which gives the tracing an appearance somewhat similar to one taken from a case of aortic disease. (In fig. 50.)

The tracing taken from the radial pulse may or may not vary according to the position of the artery previous to the chart. Normal alteration is to get the upstrokedefining the apex rounded, the secondary waves entirely obliterated.

The majority of these tracings were taken from patients in the wards of the infirmary as in private practice we do not often meet with many examples of acutaneous type having an aortic murmur and frequently among the poor than among those who are able to pay for a doctor.

Anomalies of Ascending Aorta

John von Graefen act. 28 had a large pulsating swelling on right side of chest.

Fig. 50 is taken from the right radial. Fig. 51 from the same but at a pressure of 350. Fig. 52 at a pressure of 500. Each shows a very regular pulse. Successive one beat which is smaller than the other. We see the curve (previously mentioned) in the ascending line of each of these tracings. It is very indistinct at a pressure of 350. (Fig. 52) The aortic murmur is present at the lower part of
each individual pulse wave. This aortic wave is very distinct in fig. 52.

Fig. 53 is taken from the left Radial artery. There is a marked difference between this pulse & that of the right radial. Here we see again that the first pulse wave in the tracing is smaller than the others. In fig. 53 we have a sharp sudden upstroke without any echo, instead of a rounded summit as in the right Radial we had a sharp pointed after echo & get an aortic curve (though indistinctly marked) at the end of the descending line. This indistinctness is probably due to the aortic impulse being lost in passing through the dilated aortic valve. In this case the aorta must probably affect the origin of the innominate artery, as the right Radial is much more affected than the left.

Fig. 54 is taken at a greater pressure than the other. It does not differ very much from fig. 52.

Ascending Aorta

W. Reid aged 67 had a swelling as large as a new-born child's head on the right side of his head. The patient had been confined to bed for a considerable time & there was little pulsation to be felt in the temporal. Four days ago no pulsation could be felt in left radial. Now at the present time pulsation is very slight.

Fig. 55 shows a tracing taken from the left Radial. This form of tracing is very often seen in the left Radial. Fig. 55 shows a tracing taken from the left Radial. The form of tracing is very often seen in the left Radial.
We see here there is complete absence of any diastolic or presystolic sound; in fact, we might say that the tracing was composed of undulations which occur at regular intervals. Fig. 56 is very similar to an ordinary pulse where the tension is increased. It is something similar to Fig. 46 only the tension is greater here. The increased tension is due to the greater quantity of blood which passes through the arteries of the right arm only a small quantity of blood passing through the consolided blood (which is in the leg) to the left arm; the same blood being prevented from natural communication through the aortic root to the right ventricle, the tension of the presystolic and diastolic waves are very well marked & the pulse is regular.

In the previous case the tracing had undergone little alteration, hence the marked difference between the pulses of the two cases. In one case filled with coagulated blood, in the other case the fluid blood passed through the aortic root with almost no obstruction to its flow.

Anæmia of European part of Aorta

Ed., Edwards, age 31, has suffered for some time from pulsation in the neck immediately above the sternal notch. He had pulsation & throbbing in the head increased force of the heart. He was very anxious for examination; he a swelling was visible above the supra-sternal notch which pulsated at each systole of the heart. Dyspnoea was often very distressing, the patient had much difficulty in swallowing. He complained of severe pain in the teeth, gums, & the muscles of the left side. On amplification a distinct faint sound heard above the swelling & also in the arteries at the root of the neck. The patient has been taking 2 grains of Soda of Potassium twice daily, combined
with rest in bed & suitable diet.

Fig. 57 & 58 are taken from the right & left radial arteries respectively. There is no great difference between the two specimens that the art. node is better marked in fig. 57. Fig. 58 also shows a slight pause between each pulse wave. The right arm (fig. 57) shows a quiet but apparently normal pulse tracing, the left however is not normal. The irregularity of the tracing is not apparent in the deflection since the reason why the tracing from the right radial is normal. The tracing is all in the left radial (fig. 58) than in fig. 57 but the amplitude is greater.

Fig. 39 shows an irregular pulse, the 4th beat being stronger than any of the others. It shows a few modulations in the descending line. There is a well marked predominant wave but only a very slight diastolic wave.

Fig. 60 taken immediately after fig. 39 shows very high amplitude with too tension. I had to increase the pressure of the sphygmograph from 3½ to 4½ as the needle was thrown off the paper at a lower pressure. There is a well marked predominant wave & the diastolic wave is less visible. We see again a slight pause between the systole of the heart. (See fig. 58). Some of the waves are also strongly marked than others. The cardiogram (fig. 61) shows through indistinctly the
respiratory phase. This tracing was taken at the apex of the heart between the 6th and 7th ribs. The auricular contraction is seen preceding the strong ventricular systole. The small peak which we see at the end of the descending line is due to the closure of the aortic valve. We see a short pause at the second or third beat.

Anomalous of Descending Aorta

Fig. 61. Tracing from the left radial illustrating a systolic thrill and a systolic murmur. The tracing shows the characteristic systolic flush of the aorta. The diastolic waves are well marked, and the pulse is regular.

Fig. 62 is very similar to Fig. 56 (taken from a case of aneurysm of the ascending aorta). The tracing is very high, the pulsation of the diastolic waves is well marked, and the pulse is regular.

Fig. 63 is very like that taken from the right radial. The reason for this being that the aneurysm is situated below the origin of the innominate on the right side of the aorta. A bubble on the left side does not make any alteration on either side of the bubble. The reason why the apex is flat in Fig. 63 is most likely due to the sphygmograph not being exactly on the aorta.

Fig. 64 is taken at the very summit of the aneurysm, where we find the reflex which proceeds from the smaller arterial capillaries. The tracing represented by the same at the summit. Fig. 65 is taken a little lower, the heart being further from...
fig. 64 shows a single wave with a slight tendency to a second wave, a few slight waves are seen in the descending line.

Fig. 66 shows the second wave more clearly than in fig. 65. It also shows a well marked wave in the descending line. This tracing is more in appearance to a normal tracing than the two previous ones.

Anemia of Transverse Descending Aorta

fig. 67 shows a tracing taken from a young man aged 30 who had a distinct alcoholic history. fig. 67 is from the left radial shows the tension to be rather low, the diastolic wave is very well marked. There is some irregularity of the pulse. The presystolic wave is not very distinct.

fig. 68 is from the right radial shows a better tension than the preceding. The presystolic wave is not as well marked as in fig. 67 but the diastolic is very well marked. No irregularity of the action is apparent. From a comparison of these two tracings I think we can be perfectly certain that the anemia did not affect the innominate artery nor any part of the right half of the transverse part of the aorta.

We now come to the study of the sphygmograph in relation to cardiac disease.

Valvular lesion may be congenital or acquired. I have only seen one of the former class that was in the Hospital for diphtheria children in Great Ormond St.
the first effect of any valvular lesion of the heart is to increase the number and strength of the cardiac beats so as to compensate for the deficiency in the valves. As long as compensation is established rhythmically precedes our dilatation there are no signs of backward pressure but as soon as dilatation precedes it rhythmically fails we get all the subjective and objective symptoms of backward pressure.

In our prognosis of any valvular disease we must bear in mind that the severity of the disease has no relation to the soundness of the murmurs, e.g., we may have a very indistinct murmur in which (taking into consideration the other symptoms) we can only give an unfavorable prognosis. A loud murmur only frequently depends on a low arterial tension via low arterial tension is very often due to high arterial tension.

I shall now give some tracings taken from patients suffering from Aortic disease.

Aortic Stenosis

Fig. 69 is a very good example of a "Corrigan's Pulse." The chief features of interest here are the sudden vertical steps to the stethoscope of the aortic zone. There is a very distinct precordial apex. This is not a simple case of aortic stenosis but is had in addition slight regurgitation through the aortic valves. We very frequently find that patients who have stenosis alone when we first see them ultimately develop regurgitation.

Some physicians have attributed the "Corrigan's Pulse" to slight lysis of the left ventricle but many have shown that it can be immediately produced on any aneurysm after rupture of the aortic valves.

When we have a case of aortic incompetence we
right always to bear in mind the possibility of sudden death. We have the left ventricle in such cases receiving a supply of blood from two sources (a) from its natural source - the aorta - (b) from the aorta and it may become suddenly paralyzed and cease to beat.

The pulse tracing is of great assistance in helping us to arrive at a correct diagnosis of any of these vascular lesions.

Double Aortic Insufficiency

George 48 had both a systolic + diastolic murmur in aortic area and also a systolic murmur in mitral area. The right + left side of the heart were hypertrophied + dilated. The aortae were slightly atheromatous.

Fig 70 is typical of aortic insufficiency. We get the sudden rise in the tracing the way before it reaches the summit, then we have the rapidly descending line without any indication of a diastolic wave. The sudden fall of tension is due to considerable quantity of blood flowing back into the left ventricle through the insufficient aortic valve.

Fig 71 is from the same patient as Fig 70. It shows the wave on the ascending stroke very distinctly.

Aortic Systolic + Diastolic Murmur, also Mitral Stenosis

Fig 72, 73 show tracings taken from the left + right radial respectively.
There is not very much difference between the two radicals; the left radial however shows more waves at the summit than the right.

Fig. 74. This wave shows more waves at the summit than the right.

Rheumatic Fever

I had a short attack of Rheumatic Fever, was treated with Streptomycin for four days, after which the swelling of the joints subsided. Urine contains uric acid, phosphates, and uric acid in abundance, but no crystals.

On admission, the heart sounds were normal but rather weak. The first sound was slightly improved, second sound somewhat accentuated. Temperature normal, 99.6°. The change was not a very common one. Each strong pulse is followed by a weak beat. In the strong pulsation, the presystolic and diastolic waves are fairly distinct, but the weaker one only shows a faint oscillation in the descending stroke. This pulse (Fig. 79) is known as the 'pulsus bigeminus.'

This patient was discharged much better, but the pulse did not vary in any respect from the above.

Rheumatic Fever

Endocarditis

These findings are very indistinct but they are among my earliest phonographic attempts. While in Spain during the Autumn of 1875, the patient had a severe attack of Rheumatic Fever & Endocarditis. He was very anemic and faint on raising. The heart
The heart was very much dilated, the aortic beat was made
the 7th rib, 1½ inches to outside of nipple. On palpation
a distinct thrill could be felt. On auscultation
a loud systolic and diastolic murmur were heard in
the oral area.

Fig. 76

Fig. 77

Fig. 78

The sounds are abnormal in Fig. 77 in my
opinion. It seems to consist of divisions and division
with thinning of the heart. The second fused
the third being the
highest. The second & third holding an intermediate
height the first being the lowest

Fig. 79

The pulse
shows a regular pulse, rather a protruded & diastolic
wave. The tension is not high but rather low.

Fig. 78 is after
taking digitalis.

The pulse is
regular. The upper half of the pulse wave would indicate
a low tension, but probably the sudden shock
of the intravenous syringe sends a large volume of blood into
the arteries. This reaches at first easily, but soon the
inflow is greater than the outflow & the tension
rises. This is indicated by the rounded line.

Anamn

Anamn. This tracing was taken while acting for one of the medical
surgeons at Edinburgh Hospital.

Anamn. Chronic, prominent anamn. emaciation.
may be heard at the base of the heart. Those which we hear at the root of the neck can not be depended on as we can produce murmurs at the root of the neck by the presence of the stethoscope in a perfectly healthy individual. When the patient has both a heart and an organic murmur it is very difficult to diagnose that both are present.

The following case is one which exemplifies this difficulty.

Mary Ann K. aged 15, has a history from her doctor of pericarditis, endocarditis, splenitis, with effusion. Her muscles were soft and the skin also was very soft and smooth. The mucous membranes of the lips, mouth, nose, eyes were almost devoid of blood. Unfortunately the optic discs and retinae were not examined. There was a distinct murmur at the base of the heart which was at first thought to be organic. The heart tracing however shows a distinct anemic pulse. The

Fig. 39. Anemia

symptomatic pales are present in both tracings. The heart in this case was dilated, the aortic beat appearing between the 6th and 7th ribs on each to left of nipple. The pulse was quick, she suffered from both anemic pains in cardiac region which were neither relieved by Nitrate of Ammonium, Aconitum or Digitalis. Cramm had the effect of relieving the pain while it was continued, but if discontinued for 12 hours the pain returned. This tracing was taken three weeks before her death. Post-mortem examination was performed but unfortunately had left the neighborhood before she died.
In several other cases of anaemia in whom I have used the ophthalmoscope I have found either first, superficial or even more profuse, second, haemorrhages in the retina. These cases all got better as the patient's condition improved.

**Neutral Disease**

The phlebograph is of great service to us in this form of passive disease, especially when we are unable to hear any murmurs or other signs extra-cardiac sound marks the pulmonary when it is present.

**Neutral Insufficiency**

includes all those conditions which permit of the regurgitation of blood through the left auricle-ventricular valve. While confirmation is sometimes there is not much effect on the patient, but when confirmation fails we get on again in front of engagement behind. Does change in the heart itself. The pulse differs according to the stage of the disease. The irregularity of the pulse which we see so frequently in this form of disease is due to the increased stimulation of the left ventricle caused by the auricle discharging its content at irregular periods.

**Fig. 82**

Fig. 82 gives an example of this irregularity. The patient at 4:5 had great difficulty in breathing and difficulty of face. She complained of a feeling of a palpitation of the heart. The pulse was very quick and very hot heart and beating very irregularly. So quickly that nothing could be said regarding the murmurs.

**Fig. 83**

It shows the pulse to be more regular than before. She has been taking chloro-Bell's for t.

**Fig. 84**

It shows the...
Septum - Britten - 3 hrs. Pulse not so irregular that patient feels better. The pulse at the wrist seems to number 68 but many more could be heard on auscultation of the heart.

Fig. 54 shows little change on the pulse. The patient feels better. Still taking the same medicine.

Fig. 55 shows no difference in the regularity of the pulse. As the patient did not improve under the use of the Septum, she was put on the Diphtheria when she began to improve rapidly. I left alone about the time but was told by Dr. Mauer that her pulse became perfectly regular and she was discharged much better. The trial of the Septum here is not very promising probably the slight improvement which took place was chiefly due to rest in bed. I have never used Septum nor have seen it used at any other Time.

Fig. 56 shows very little concerning its use in Mitral Disease.

The above readings resemble very much those taken for a patient suffering from adherent Pericardium.

Fig. 57 shows another illustration of a mitral systolic murmur. The heart was dilated, the skin heated between the chest, the ribs, and the chest line. Fig. 58 shows the same, the tension is pretty good, some heat on sternum, others quiet. No sweat.

The patient has been taking 4 oz. of F. Aamolam.

Fig. 59 shows a tracing taken at the apex of the heart. Some of these pulsations are normal while others are pathognomonic of a mitral lesion.
the table on the tracing shows the effect of 4 g. of Diatrem in the morning on the pulse.

Fig. 87, taken one week later, still shows an irregular pulse. He is now taking 60 g. of T. Canadensis.

Fig. 88, taken at the same time as Fig. 87, is quite pathognomonic of a mental tone.

Eugene Morkins, an amniss young woman, got a cold and a fever of some palpitation in carotid region. She had rheumatic fever eight years ago. On examination there was a systolisch regurgitating murmur heard.

Fig. 89 shows a pretty good tension, the amplitude is low. The pulse is irregular.

Fig. 90 is the cardiogram taken at the same time as the pulse tracing. It shows the effects of reflexes.

Fig. 91 shows a somewhat stronger pulse. The patient felt better than had occurred. She is now taking Digitalis & Co.

Fig. 92 shows a more natural cardiogram tracing than Fig. 90. The aortic valve is stenosis. The pulsation of the ventricular systolic murmur at the beginning of the ascending stroke.

Amelia Smith was a loud ventricular systolic pre-systolic murmur. She had been taking Digitalis...
for some time felt very well. Fig 95 is a tracing of
her pulse
which was
regular and
regularly
irregular.
Fig 95 systolic
frugostolic
murmur
in
especially the diastolic waves are well
marked. The tension is good and the tracing is practically
normal. This tracing illustrates the beneficial effect
of Digitalis. This is more apparent when we compare
it to Fig 96 taken from a patient who had undergone
no treatment.

Michael Evans at 30 had bronchitis, edema of lungs
and face. Ascites was well marked. A systolic
frugostolic
murmur could be heard very
distinctly at the apex of the heart. These murmurs were
propagated towards the aorta. Fig 96 shows a very irregular
pulse typical of a Mortal lesion. The pulsations could
not be counted by touch owing to the rapidity of the heart.
The patient being very distressed suffering severely from
dyspnea was given Digitalis, Ammonia, etc., and was
very quickly shown signs of improvement. In such a case as
this our progress must always be gauged not only how
we take into account the extent of the lesion, the
severity of the dyspnea, bronchitis, edema of lungs, combined
with general edema of the body, but we have also to take
into account the length of time that medicines will
take before the urgent symptoms will be relieved. Efficient
through the rapidity of action wards off the immediate
dangers of

Fig 97 Systolic murmur.
felt in proceedings. The pulse was regular, presystolic
diastolic waves fairly prominent, the tension was pretty
good. There is nothing abnormal in Fig. 97.

Fig. 98 shows
the respirator
line very well.

The auricular wave is also exceedingly well marked espe-
cially at every 4th beat.

Isabella Watt, aged 47, had been in the Hospital undergoing
treatment for a month before this tracing was taken. She
took Atropa in small doses twice a day. This lower
the arterial pressure increases the number of pulsations
of the heart.

Fig. 99 shows
a low tracing

An increase of the number of pulsations. This is not as
much troubled with palpitation of her gout is much
less marked than previously. The erethism is also
much less.

I now wish to mention all the diseases which I consider
to be necessary in illustrating the utility of the sphy-
ograph and shall now give one or two examples of its
use in Therapeutics.

Nitrite of Amyl

Fig. 100 is a normal tracing.

Fig. 101 is the beginning of the
inhalation. Again to.

Fig. 102 is taken one minute
after cessation of Nitrate
of Amyl. The pulse is return-
to its normal condition to show
a well marked diastolic wave.

Fig. 103 Two minutes after cessation.

Pulse is not as fully diastolic.
as previously, otherwise little different from Fig. 102.

Fig. 104 taken five minutes after
is almost a normal tracing.

Nervous Gases

I now come to this substance
the effects of which on the pulse
I do not think has been previously
observed by means of tracings.

Tracings, when taken from healthy individuals
are sometimes affected by this gas so that they could have
their teeth extracted quickly.

Fig. 105 shows the pulse.
Tracing before the inhalation
was begun. The pulse was
somewhat quick owing to excitement.

Fig. 116 was taken when
the gas was breathed by the
patient. The pulse is now
very much quicker, the tension in other parts of the respiratory
system is clearly seen. The pulse is fully diastolic, and in a
few tracings it shows a tendency to hyperdiastolic.

Fig. 107 taken while the patient
was deeply under the anaesthetic,
the heart action being greatly
accelerated. The hyperdiastolic is more plainly seen
in several of these pulsations.

Fig. 108 taken immediately after the
extraction of tooth shows that the
pulse is gradually returning to its normal condition.

The chief use of the sphygmograph is to
be found in its application to disease of the vascular system. Many other
diseases alter the pulse-
tracings, but so far as I am able to judge from the
specimens which I have given in this shape, there is
nothing sufficiently pathognomonic to enable us to say from an observation of the tracing that the patient is suffering from any particular disease. The sphygmonograph is of much utility to an air helping us to observe the progress which the patient makes from day to day by a comparison of the various pulse tracings which have been previously taken. But as an auxiliary to the diagnosis of any disease outside of the vascular system I think it is entirely useless.

In diseases of the vascular system it is of great assistance to the Medical man. It is also of the utmost value in Thrombosis so that we are now able to say positively the effect or non-effect that any drug has upon the heart or vessels.

Not only is it of great diagnostic value in all cardiac disease but also of very great use in all cases of doubtful aneurism. I have seen a tumour situated over the abdominal aorta diagnosed as an aneurism by many eminent Medical men in London who very likely the sphygmonograph would have cleared up the doubt. If the swelling be a tumour we apply the sphygmonograph below the swelling & apply pressure but if we would find the amplitude of the blood wave as recorded by the sphygmonograph very much reduced in size. If on the contrary the swelling were an aneurism then the amplitude would be very much increased.

Another advantage which we can claim for the sphygmonograph is that it makes us much more precise observers than we otherwise might be. We can also make a few notes of each case on the tracing paper which would be available for reference at any time.

In cases of paralysis also it might be of some use. The case of thrombosis which I have previously written about shows that not only is there a paralysis of the
muscles of the affected side but that the vessels also share in this paralysis. This of course is just what we would expect but as far as I know attention has not been drawn to tracings taken from both sides of the body. It is just possible that we might find some change in the tonicity of the vessels in other forms of paralysis besides Bellpalsy. At any rate it will be interesting to note whether (in a case where recovery is taking place) the first sign of improvement does not show itself in the increased arterial tonicity. It will also be interesting to note whether (in a case of permanent paralysis) the arteries also remain permanently paralysed or whether the vasomotor nerves regain their usual influence independently of the motor paralysis.

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