Thesis for degree of M.D. Edin.

By J.R.P. Lambert. M.B.Ch.
11 Sydney Place
Onslow Square S.W.

On intra thoracic Aneurism with some observations on the use of the Sphygmograph

Having during the last 18 mos met with 3 cases of intra thoracic aneurism, all of which present points of considerable interest, I have decided to make these the subject for my thesis.

The rarity of aortic Aneurism in women is well known. I recollect Prof Greenfield teaching that "aneurism of the arch of the aorta is almost unknown in women, most cases thus diagnosed turning out to be abnormalities in vessels" The patient who gave occasion for this remark was a woman who presented symptoms of aortic aneurism (& still have clinical notes of the case) It is therefore worthy of note that 2 of my 3 cases were women, & in one of these cases I recently had the opportunity of confirming the diagnosis

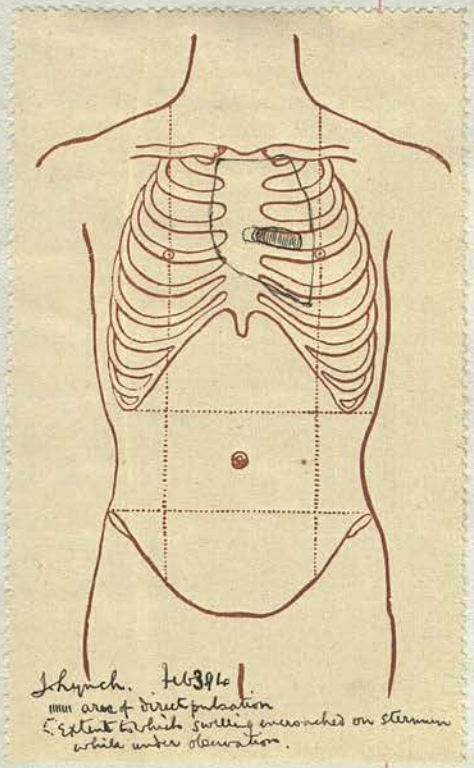
of aneurism of the arch of the aorta, by post mortem examination. The chief point of interest in the third case is the position of the tumour which presented in the 3rd left intercostal space.

Before making any further remarks I will repeat my notes of the cases in order of observation.

Case 1.

John Lynch aet. 43 an old Soldier, working lately as a porter came under observation in Jan 94. He gave the following history. For 2 years he had suffered from pain in the chest. Six months after the pain commenced, a swelling appeared on the left side of the chest, & at the same time he had a bad cough & complained of pain down the left arm, & had to give up work. Three months before he came into my hands he had been in the Royal Free Hospital where he said he was given Iodide of Potash & was dieted to a skeleton, but without improvement.

He gave a history of Syphilis, & had done much heavy work, but was not aware of having strained himself at any particular time.
On inspection of the chest there was manifest an elongated pulsating tumour in the 3rd left intercostal space measuring roughly 3 inches by 1½ inches, reaching nearly to the middle line. The apex beat was visible in the 5th space just inside the nipple line. There was also visible pulsation in the epigastrium & in the right supraclavicular fossa.
On palpation pulsation could be felt for some distance above the swelling & also by placing the hand on the left scapula.
On auscultation a loud systolic bruit was heard - most intense over the tumour, but also in all the cardiac areas except at the apex. The bruit completely disappeared in the erect posture. It


Lehynch. Feb 3/14
area of direct pulsation
Extent to which swelling encroached on sternum
while under observation.

was also heard all over the right side of the chest in front.
The 2nd heart sound was very accentuated - short + sharp, most markedly over the swelling + in the aortic area.
The heart sounds could be heard all over the back of the chest.
On percussion the cardiac dulness was found to extend about 1 inch to the right of the sternum, + there was dulness upwards from the base to the clavicle.
The pulse was full slow 54, of good tension - rather high as the tracings will show.
Examination of the lungs showed some impairment of the percussion-note on the left infra-axillary region + in the interscapular regions.
The breath sounds were noted to be much louder on the left side posteriorly - especially inspiration, which varied in character being at times prolonged + broken, + at times, short + loud. On the left side anteriorly in the mammary

region only one respiratory sound was heard, a loud short inspiratory sound as though some obstruction were suddenly overcome. This was noted on several occasions.
There was no inequality of the pupils, which reacted well to light. Tracheal tugging could not be felt. The patient complained of pain down the left upper arm & thro' the left side of the chest at times; also of dyspnoea & palpitation & a dry cough, induced by moving about. He had no gastric symptoms except occasional slight flatulence. His bowels were regular, but he had attacks of diarrhoea occasionally. The urine was found to be normal. He remained under observation for several weeks during which time the swelling seemed to consolidate towards the outer part while it encroached on the sternum across the middle line. He was kept at rest & on low diet, no more iodide was given. Then lost sight of him completely.

Case 2.

Matilda Godwin Ret 50. Came under my observation in July 94. Four years previously she had been under my friend D-Spencer Cox from whom I have obtained the following history & notes. The patient had been well & strong as a girl but had had measles & scarlet fever. At the age of 21 she had rheumatic fever, & in the same year also nephritis & dropsy, & was so ill that she could not walk without crutches for 3 years. She married at the age of 17 & had 9 children of whom only 2 were living in 1890. Since the last child was born she had 3 miscarriages. the last of which was in '82 & since then she never was regular & suffered from a yellow leucorrhoeal discharge. In '89 she had a rash on the arms & had been troubled with sore throats 2 yrs previously. She had also noticed (for at times that her hair

was falling out.
She gave the following account of her illness. Two months previous (ie July, 90.) she felt a dead pulsating in the right side of her chest & at the same time noticed a swelling in that region. She rested more or less for 3 weeks but without improvement. For some time previously she had felt the housework severely but was not aware of any strain or blow. Her condition then was noted as follows - patient was fairly well nourished, of rather anxious expression. On the right of the chest there was visible a pulsating swelling causing decided bulging of the rib. It extended from the junction of the 2nd cartilage & sternum outwards for 3 inches & downwards to the upper border of the 3rd rib. There was a thrust over it, & also up & down the sternum. Pulsation could be felt in the episternal notch. The heart was noted to be enlarged

the apex beat was in 6th space 2½ inches below & outside the nipple. There was a diastolic bruit at the base & a presystolic bruit & thrill at the apex.
The breath sounds were noted to be weak on the Rt side & exaggerated on the left ~~pos~~ at the bases.
The urine was free from albumen.
She was kept at rest & on low diet for some 6 weeks during which time the tumour decreased in size & the pain of which she com-plained in the right side entirely disappeared.
I had the opportunity of seeing her once or twice last July & August & took a few tracings. There was then no visible tumour but pulsation could seen & felt & dulness mapped out in the region described. There was also a double bruit up & down the sternum. I did not see her again alive.
On Mar 4. last she died rather

Suddenly, & I had the opportunity of making a post mortem examination of the chest, tho' under great difficulties unfortunately. I found on opening the chest a considerable amount of blood in the pericardium. The heart was considerably enlarged from hypertrophy & dilatation of the left ventricle & dilatation of the right. The aortic Valves were incompetent & somewhat thickened. There was a large aneurism involving the whole ascending part of the arch of the aorta & part of the transverse as far as the origin of the innominate, which was not involved. It was chiefly the convexity of the arch that was affected. The aneurism was very firmly adherent to the ribs anteriorly but had not eroded them. The anterior wall of the sac was as thick & in parts thicker than normal aorta, & very similar in appearance except for atheromatous patches.

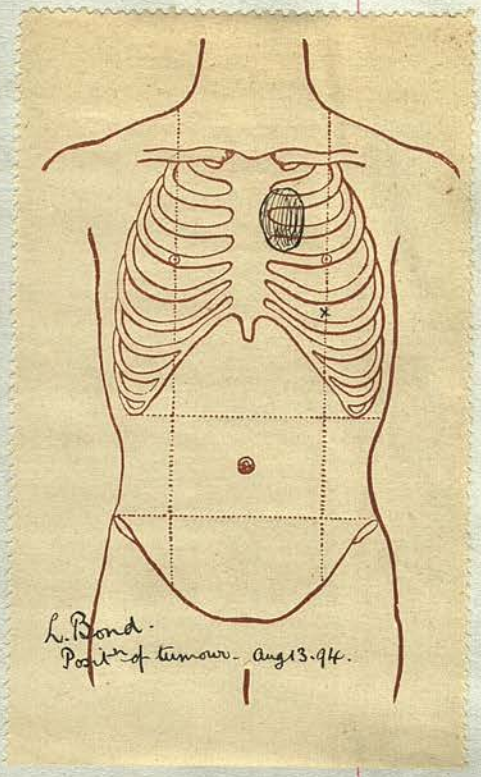
while the posterior wall of the Sac was markedly thinned & of a red-dish colour, & at the thinnest part appeared to have ruptured, but the Specimen was unfortunately rather damaged in removal, & it was difficult to say what rupture occurred before death & what during removal. The internal surface of the aneurism presented numerous patches of atheroma, some very large, & there was a thick fibrous band across one side forming a deep pouch on each side of it & having a thick free edge. The whole aneurism was about 10 inches in cir-cumference.

Case 3.

Louisa Bond aged 58 under observation last August when she gave the following account of herself. She had always enjoyed good health except for an attack of 'congestion of the liver & obstruction of the bowels'

from which she suffered 3 yrs previously. She had had no children & no miscarriages.
Since Sept 93 she had complained of pain in the left side of the chest going round to the back, & 2 months after the pain commenced she noticed that she was short of breath on exertion.
In March 94 she first discovered a swelling on the left side of her chest which had since increased in size.
When I saw her I noted that on inspection of the chest there was visible a pulsating expansile tumour on the left side of the sternum & invading it slightly. It extended from the upper border of the 2nd to the upper border of the 4th rib. It was very tender on palpation & pulsation was felt to be more direct at its upper part. The pulsation extended outwards as far as the

nipple line & visibly travelled from right to left. The tumour was uniformly soft - nothing could be felt of the cartilages involved. On the placing the hand on the left scapula indistinct pulsation could be felt. The apex beat was in the 5th space & the nipple line. On auscultation there was heard a systolic bruit over the tumour & a very faint diastolic. The heart sounds were muffled in the aortic area, & the Blood no bruit was heard there, but the 2nd sound was heard accentuated over the tumour & in the mitral area, & a systolic bruit could be heard down the sternum & in the mitral area. The heart sounds could be heard all over the back of the chest specially over the lower part of the left scapula. There was no difference in resonance over the back of the chest on


L. Bond.
Post. of tumour. Aug 13. 94.

on percussion. The heart sounds at the left base were noted to be jerky, & louder than on the rt side. The pupils were equal but somewhat dilated. The urine was normal
She complained of attacks of severe pain passing from the tumour round under the left axilla to the scapula - sometimes also on the right side. The attacks were brought on by coughing or laughing, but also came spontaneously. During the attacks her face was flushed & I noticed that the left pupil was larger than the right. This was also so occasionally, when she was free from pain.
She was kept at rest & on low diet for six weeks during which time the swelling became much less prominent, but the pulsation seemed more diffused. While thus at rest she had more

pain than she had while getting about. I found that small doses of nitroglycerine (ℳj of 1% sol) relieved the pain for a time, as also did Amyl Nit in doses of $\frac{1}{5}$ of a minim, but after a time the relief thus obtained ceased. I have never used these drugs continuously in aneurism, but they might prove of service where the blood tension is high. In this case they were only used as a palliative for the pain during severe attacks.

The first point for discussion in connection with these cases is the diagnosis in the first & third. In both of these cases the expansile nature of the pulsation & its direct character at once dispose of the possibility of a solid tumour being in question; it therefore remains to decide what part the aneurism springs from. The position of the tumour, on

the left side, would point to aneurism of the transverse portion of the aortic arch or possibly the descending aorta, or both, rather than the ascending part.
In the case of Lynch the position of the tumour was peculiar, & would suggest the possibility of aneurism of the pulmonary artery, but the tracings taken over it, together with the great rarity of such a condition leave little doubt that the aorta is the vessel involved & the area of dulness points to the same conclusion.
The fact of its presenting a tumour in the 3rd & not the 2nd Space would suggest a weakness of the wall of the sac at (3rd Space) that part.
The tracings taken over the sac compared with those at the wrist show but little difference, only the tension is more marked over the aneurism. (Vide p. 16 infra)
The 2 radial tracings show very

little difference on the 2 sides (the only difference being slightly more tension on the left side) which would point to the whole transverse portion of the arch being ~~involved~~ affected & the origin of the innominate involved & the fact that pulsation was visible in the right supra clavicular region adds support to this view.

Tracing. 1

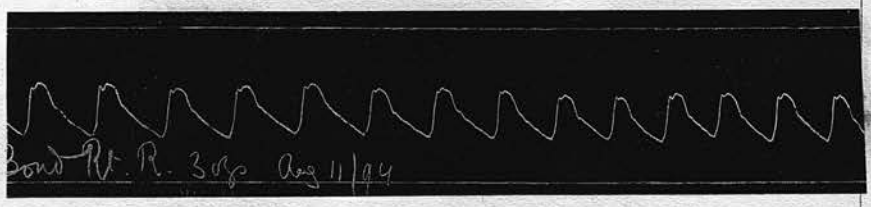
Tracing 2.

On the other hand the absence of tracheal tugging is rather against aneurism of the transverse arch, but as a negative symptom is not of much value. Then again the fact that pulsation could be felt over the Lt scapula points to descending

Aorta being affected as well, & the Symptom of pain down the left arm favours this view, pointing to pressure on the inter costo-humeral nerve. The conclusion therefore is that the aneurism involves the transverse portion of the aortic arch & the first part of the descending aorta.

In the Case of L. Bond (Case 3) the following tracings indicate that the position of the Aneurism is beyond the origin of the innominate artery the apex of the wave being decidedly more rounded in the Lt radial tracing.*

Tracing 3.



4

The position of the tumour is more typical of aneurism of the transverse arch than in the previous

* The right pulse however, also shows signs of aneurismal modification which would point to the innominate being involved to some extent tho' the tumour lies chiefly beyond it.

Case. The absence of visible pulsation in the left supra clavicular region is against aneurism of the left Common Carotid or left Subclavian, & the fact that the pulsation in the tumour travelled visibly from right to left is strongly in favour of Aneurism of the transverse arch, moreover the fact that pulsation could be felt over the left scapula accords with this view. As in the previous Case tracheal tugging was not elicited, possibly in both cases thro' defective method of Examination. However I am distinctly of opinion that this Case is another example of aneurism of the Aortic arch in a woman. The only other condition which would account for the Symptoms & Signs would be an abnormal origin of the left subclavian from the ascending aorta.

WW

with aneurism, but I have not found any record of such an origin of the left Subclavian. Before passing on to consider further the value of pulse tracings in aneurism, there is a point which I think worthy of consid-eration namely alteration in the character of the breath Sounds at localized parts of the lung. In both the cases which we have been discussing I noted a peculiarity – in one case the breath sounds were described as being at times short & sharp as if an obstruction were sud-denly overcome (this was observed only over a small area) – in the other both cases the sounds were des-cribed as being jerky, or it would perhaps be more accurate to say interrupted at the base. In both these cases it occurred to me that the alteration might be due to a bronchus having been eroded

allowing the aneurism to protrude into its cavity, or being compressed by it, in either case in such a way that the branches was only occluded when the artery was dilated.

In both these cases the breath sounds were noted to be louder on the left than the right side, which might be accounted for by compression of the lung & consequent increased elasticity. In the third case where the Aneurism was on the right side, the breath sounds were feeble at that base probably owing to compression of a large branch.

We come now to the discussion of the value of pulse tracings in cases of aneurism in connection with which I must say a word the subject of the predisposing causes of aneurism for here pulse-tension plays an important part being one

of the two predisposing causes
the other is disease of vessel
walls (arteriosclerosis). The
chief conditions which furnish
one or both of these causes are:-
Syphilis - Bright's disease (Chr) - alcoholism
Gout, lead poisoning & constipation + Strain.
In connection with Syphilis which
has long been regarded as a
most important factor in the pro-
-duction of aneurism, it is of
interest to note Dr. G. Oliver's
observation in his book on "pulse
-gauging" (pp 37-8) (p 56 et seq) where he says
he has found that Syphilis greatly
diminishes or abolishes the postu-
-ral changes in pulse calibre, for
which he concludes that it has
an extensive effect on the walls
of the vessels.
Arterial disease however though
a very important factor is probably
not enough to produce aneurism,
but increase of pulse tension is
necessary either temporary or

permanent. Muscular strain causes a temporary increase in pulse tension & is probably by far the most frequent immediate cause of aneurism. Suppose a vessel with diseased walls & increased tension; there must be a constant tendency for the wall to give & a sudden increase of tension may determine this event. Very often the patient is conscious of something giving way, tho' none of my cases noticed this. Where there is only a weakened vessel wall, frequent muscular strain would furnish the additional factor, but the production of an aneurism under such circumstances would probably be more gradual than where permanent tension exists as well.

Prof Chiene used to say that in some cases at least, an aneurism might be regarded as a natural safety valve. Where the increase

of tension is due to deficient elasticity of the vessels, this it is easy to understand that an aneurism may make up for the want of expansion in the arteries. Moreover an aneurism if of any size would tend to equalize the pressure at the commencement of the pulse wave when it is highest, & thus diminish the risk of haemorrhage which is the other great danger of weakened vessel walls. But an aneurism to deserve this designation must have strong elastic walls, else it becomes a source of greater danger than the risk of haemorrhage.

We come now to the effect of an aneurism on the pulse as shown by tracings & the value of these as aids to diagnosis & prognosis.

The usual tracing shown in text-books as ~~typical~~ an aneurismal pulse

is simply a rounded wave with no notches or secondary waves, but it is possible to have a large aneurism with no alteration in the pulse wave in any way typical. The first change an aneurism produces in the pulse ~~tracing~~ is delay in pulse wave; further changes are in the direction of lowering tension & obliterating the notches & secondary waves. The conditions which effect these changes we shall now consider. The following tracings are of considerable interest. I took them from a patient whom I saw but once, a woman again, Mrs Gunn, who has an aneurism of the right common Carotid about the size of a small hen's egg, with apparently a strong elastic sac-wall. The tracing taken over it shows violent pulsation & a marked elastic or tidal wave. The tracing over the external

Carotid beyond it, when compared with that taken over the ~~left~~ right Ext Carotid artery shows well delay of the pulse wave - the line of ascent forming a curve almost at an angle at ~~times~~ times eg. tracing 6 infra a, a. The tidal wave or elastic elevation (Landois) is more marked & of shorter duration than on the left, showing slightly lower tension. ~~follow~~ The fact of its rising higher is due to the greater elasticity of the aneurismal sac as compared with the healthy vessel on the other side.

Tracing 5

6.

7

In a case like this if we suppose the elasticity of the wall to be increased

So that it expands more easily two results will follow - the wave will be more delayed & the tension will be diminished. If in addition we suppose a loss of contractile power the result will be more or less obliteration of the secondary waves. Thus the weaker & more expansile the wall of the sac, the more will the pulse wave beyond it, approach a simple curve. On the other hand, the stronger the sac wall & the less its expansibility the less will it affect the pulse wave beyond. For, I take it that an absolutely rigid aneurism if we may suppose such a thing — would not delay the wave nor alter its constituent parts; & if we suppose the rigid wall to become elastic, no alteration would occur till the expansibility exceeded that of the normal vessel while the contractile power is less. This would explain the possibility of the existence of an aneurism

of considerable size without any appreciable change in the pulse wave, as was the case with J. Lynch. (Tracings 1 & 2). I do not think such tracings could be obtained if the sac wall were thin & gave easily, unless the sac communicated with the artery only by a small opening, in which case the effect on the pulse would be much less marked for in that case the pulse wave would not pass thro' the aneurism at all, but the tension would be lowered somewhat at the site of the aneurism.

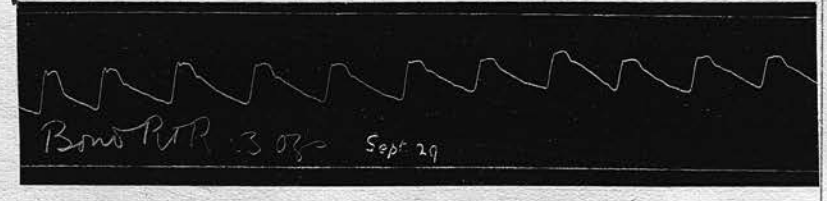
This is easily seen from a simple diagram.

This suggests another point - that the greater the surface of arterial wall affected the more marked will be the effect on the pulse. Consequently, other things being equal (ie elastic expansibility & recoil) the greater the aneurism the more

marked its effect.
We have seen how an aneurism in the course of artery may convert the normal pulse wave into a simple curve. If now the aneurism be very large the pulse wave may be obliterated altogether as occurred in a case referred to by Dr. Osler in his book on the Practice of Medicine p. 674. In order to produce such a condition the aneurism must be of such size & expansibility as to easily hold all the blood which has to pass thro' it at each beat of the heart in addition to the quantity which it contains in the state of contraction & thus it acts as a sort of reservoir.
From what has been said it follows that ~~an aneurism~~ rounding of the pulse wave is an index of the size of an aneurism & the state of its walls but by no means a necessary accompaniment

of an aneurism even of considerable size as that in the case of Lynch evidently was. If on consecutive examinations the wave became more curved it would indicate a giving of the wall & increase in size of the sac, & thus this sign may be of considerable prognostic importance. As an example of this, if the following tracings be compared with Nos 3 & 4, taken from the same case (Bond) 6 weeks previously it will be found that in the later tracing the left radial wave is distinctly more rounded than in the earlier one (No 4) which I gather that the patient had not improved but lost ground, & the increased pain points to the same conclusion.

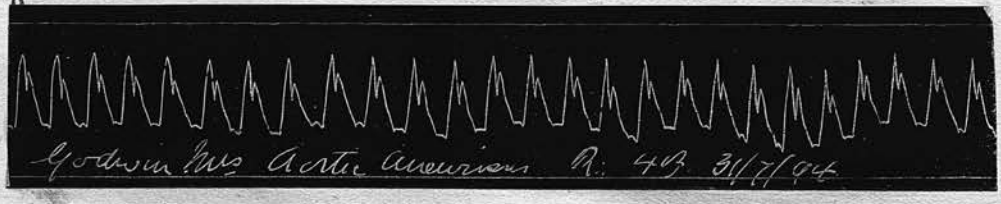
Tracing 8

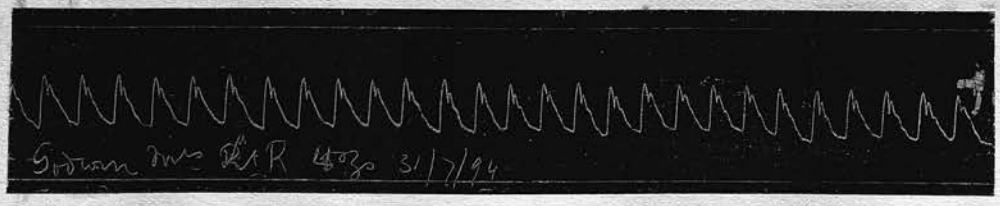


" 9

We have shown how the rounding of the pulse may aid in diagnosing the site of an aneurism. Of necessity it may lead to the diagnosis of the existence of an aneurism in a doubtful case, but what from we have said it is of value only as a positive sign as an aid to diagnosis. As the absence of this sign would be favourable in a case of undoubted aneurism.

We shall now consider the tracings taken from Case 2. (aneurism of ascending arch). Here again we find nothing typical of an aneurism. The accompaniment of aortic regurgitance may in part account for this.





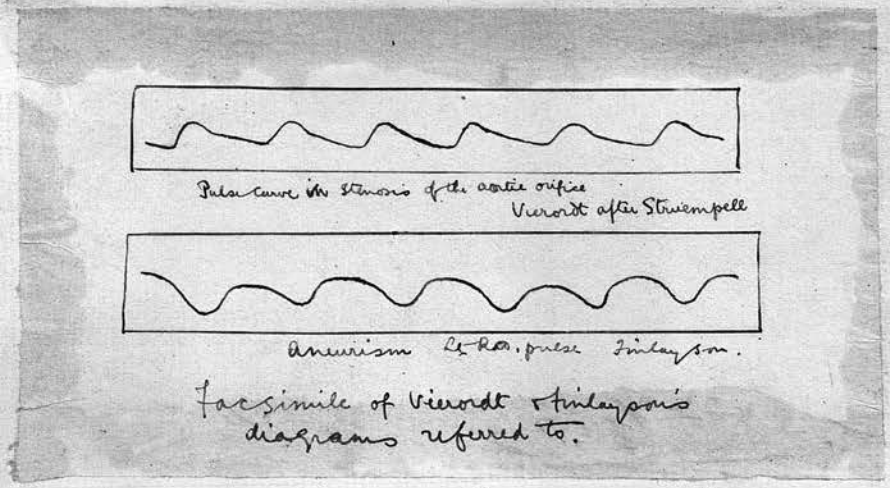
Tracings 10 & 11

we may however learn something from these tracings which exhibit more of the alteration caused by aortic regurgitance, which coexisted. The presence of aortic regurgitance may therefore completely destroy the value of the tracing as an index to the existence of a condition of an aneurism; on the other hand an aneurism may so modify the character of an aortic regurgitant pulse as to give a suspicion of its existence.

There is another point of interest in these tracings viz the small wave just before the up stroke. Dr Byrom Bramwell in his "Studies in Clinical Medicine" p117 gives a tracing taken from an aneurismal tumour with a cardiograph where a similar small wave occurred, which he thinks due to the auricular systole. I have not obtained it in my tracings taken

over aneurismal tumours.
In connection with the modification of the pulse wave there is one other point which deserves notice, it is the effect of aortic stenosis on the pulse. This affection also tends to produce rounding of the pulse wave, & Vierordt in his 'Medical diagnosis p. 249. gives a diagram of a pulse of aortic stenosis in which all the secondary waves are obliterated. A marked degree of stenosis would be necessary to produce such a pulse, but even this could be differentiated from an aneurismal pulse in which the secondary waves are obliterated, because an aneurism tends at the same time to equalize the pressure throughout the wave & to diminish it. The curve would therefore be longer & the space between the waves less. Finlayson in his Clinical Manual

p. 695. has a diagram which illus-
-trates this well.



facsimile of Vierordt & Finlayson's
diagrams referred to.

From what we have said we may
sum up the following conclusions

1. An Aneurism may exist without
modifying the pulse-wave. Absence of
modification is a favourable sign
pointing to a sound Sac wall.

2. Modification may occur in 3 ways

(a.) delay of wave.
(b) Equalisation & diminution of tension.
(A sacculated aneurism diminishes tension (only)
(c.) Obliteration of secondary waves &
the formation of a curve. (Liable to
fallacy from aortic Stenosis)

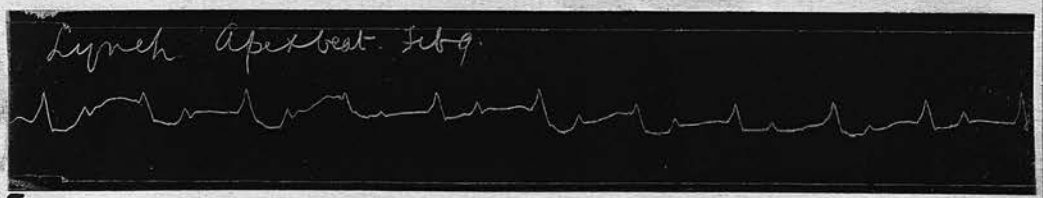
3. Rounding of the apex of the wave is an
indication of (a.) Existence of an aneurism
(b.) The state of its walls.
(c.) Size of aneurism. It is
probable that it only occurs in large aneurisms.
The larger the tumour & weaker its wall the more marked
will be the curve.

4. Obliteration of pulse shows a very large
aneurism.

5. The pulse tracing may therefore aid in diagnosis & prognosis, & in every case tracings should be made at intervals. If the wave becomes more rounded it is an unfavourable sign - as also is diminution of tension.

The following tracings taken over the aneurisms in the cases of Lynch & Bond are perhaps of more interest than value, & may be compared with the apex beats from the same cases.

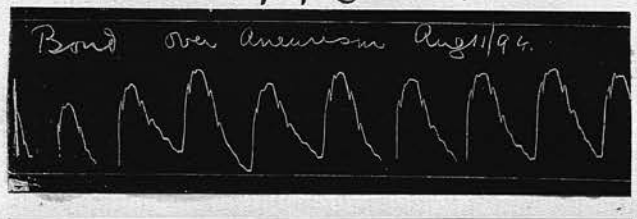
Tracings 11 & 12



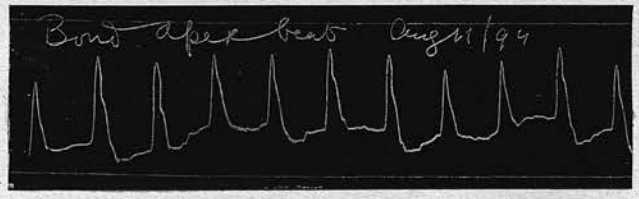
In the tracing of the apex beat of Lynch there is a point of some interest - viz the long interval between the what I take to be the

auricular wave & the ventricular.
It has occurred to me that this peculiarity in rhythm, (& perhaps ~~together~~ also with the slowness of the pulse, 54 per min.) may be accounted for by pressure on the cardiac nerves.
The following tracings are from the case of Bond & were taken on the same days as the radial tracings 3 & 4 (p. 17) & 8 & 9 (p. 29) respectively

Tracing 14

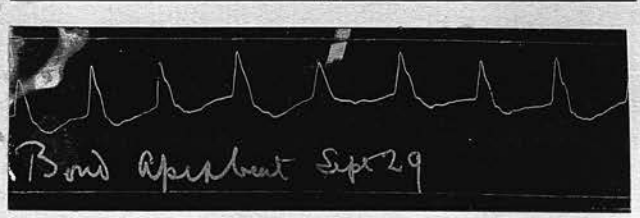


" 15



" 16

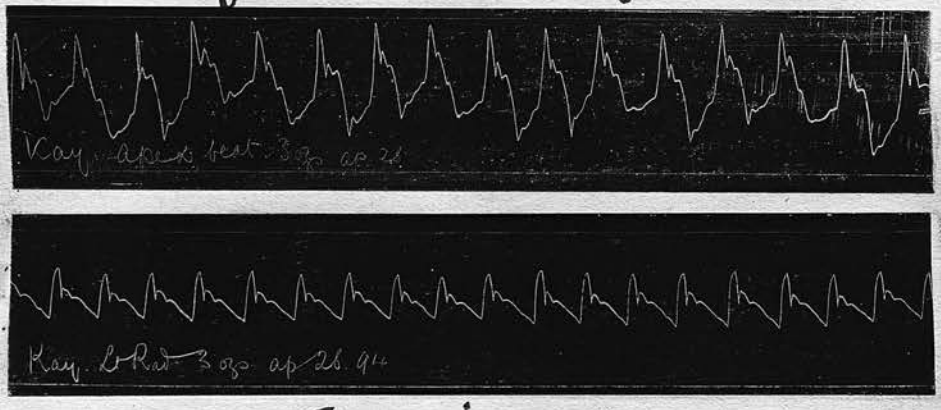
" 17



The latter as compared with the former show diminished cardiac activity but in spite of this as we have seen

there were evidences of increase in size of the aneurism (pain & more marked rounding of the swelling) so these tracings would make the prognosis still more unfavourable, & the only report I heard of the case after she passed out of my hands was very unfavourable.
The Sphygmonal tracing No. 16 shows a great resemblance to the left radial tracing taken on the same day No. 9 (p29).
In tracing No. 14 a number of small waves are observed in addition to those of an ordinary pulse, which I regard as representing the thrill so common in these cases, & doubtless due to elastic vibration of the sac.
In conclusion I must say that all these tracings without Exception were taken by myself with a Dudgeon's Sphygmograph. I am not aware that this instrument

has been used in this way before as a cardiograph, for aneurismal tracings - nor have I seen any aneurismal tracings besides Dr. B. Brannell's. I think the tracings show that the instrument can be used efficiently for the purpose. The apex tracing No 12 is not very good, but the following shows can be done in this way. I took it from a case of



Tracings 18 & 19.

mitral regurgitation in a girl of 12 where compensation was, so far as could be judged, perfect.

Of course the cases in which a good apex tracing can be obtained with this instrument are limited but it can usually

be done where the apex beat is easily visible if the intercostal space is fairly wide.