Thesis for degree of M.B. Enn.
By J.R. Lambert, M.B.Cm.
17 Sydney Place
Baker Square S.W.

On intra-thoracic Aneurism
with some observations on the use
of the Sphygmo-Graph

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. Recol-
lect Prof. Geddesfield 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.
(As still have clinical notes of the case)
It is therefore worthy to note that 2
of my cases were women, 3 of me
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 report my notice of the cases in order of observation.

Case 1.

John Lynch, aged 43 an old soldier, worked lately as a patient 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. He complained of pain down the left arm, and 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 potassium, and dieted to a skeleton, but without improve-

ment.
He gave a history of syphilis, and 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 2 inches by 1½ inches, reaching nearly to the middle line. The apex beat was visible in the 3rd space just inside the nipple line. There was also visible pulsation in the epigas-
tricular, and in the right supercili-
ular fossa.

On palpation pulsation could be felt for some distance above the scull, also by placing the hand on the left Scapula.

An 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 disap-
ppeared in the erect posture.
was also heard all over the right side of the chest in front.

The 2nd heart sound was very accentuated, short, sharp and marked by a slight rattle over the swelling on the anterior area. The heart sounds could be heard all over the back of the chest.

On percussion the cardiac dullness was found to extend about 1 inch to the right of the sternum, there was dullness upward from the base to the clavicle.

The pulse was full and 5th, 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 region.

The breath sounds were noted to be much louder on the left side posterior, especially inspiration, which varied being at times prolonged and broken, at times short and 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 and the left side of the chest at times; also of dyspnoea and palpitation. A dry cough, induced by moving about, was noted.

He had no past symptoms except occasional slight flatulence. His bowels were regular, but he had attacks of diarrhoea occasionally.

The arm 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 spread on the sternum across the middle line. He was kept at rest on a low diet, no more solids being given.

...
Case 2.

Matilda Gordon, age 50. Case under my observation in July 1894. Four years previously she had been advised by my friend, Dr. Spencer Cooke, from whom I have obtained the following history and notes. The patient had been well and strong as a girl, but had had measles and scarlet fever. At the age of 31 she had rheumatic fever, in the same year also nephritis. Nephritis was so severe that she could not walk without assistance for 3 years. She married at the age of 17 and 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 1882. Since then she has been regular and suffered from a yellow leukorrhoeal discharge. In 1889 she had a rash on the arms, had been troubled with sore throat 2 yrs previously. She had also noticed it at times that her hair...
was falling out.

She gave the following account of her illness. Two months previous (in July, 190) she felt a steady full beating in the right side of her chest, at the same time noticed a swelling in that region. She noted same or less for 3 weeks but without improvement. In 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 a visible pulsating swelling causing decided bulging of the ribs. It extended from the junction of the 2nd cartilage-sternum outward for 3 inches downwards to the upper border of the 5th rib. There was a knot here it, which up 5 down the sternum. Pulsation could be felt in the suprasternal notch. The heart was noted to be enlarged
the apex beat was in 6th space 2½ inches below and outside the nipple. There was a diastolic limit at the base on a presystolic limit & thirll at the apex.

- The heart sounds were noted to be weak on the right side & exaggerated on the left side at the base.
- The arms were free from albumin.
- She was kept at rest on hard diet for some weeks during which time the tumour decreased in size & the pain of which she complained on the right side entirely disappeared.

I had the opportunity of seeing her once or twice last August & took a few tracings. There was then no visible tumour but pulsation could seen & felt & these were mapped out in the region described. There was also a double beat up & down the sternum. I did not see her again alive. On May 14, last she died.
Suddenly, I had the opportunity of making a post mortem examination of the heart, this under great difficulties, unfortunately. I found an opening the chest a considerable amount of blood in the pericardium.

The heart was considerably enlarged from hypertrophy and dilatation of the left ventricle and dilatation of the right. The aortic valves were incompetent and somewhat thickened. There was a large aneurysm involving the whole ascending part of the arch of the aorta and 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 aneurysm was very firmly adherent to the ribs anteriorly but had not spread them. The anterior wall of the sac was as thick or in parts thicker than normal aorta, very similar in appearance, except for atheromatous patches.
while the posterior part of the sac was markedly thickened, of a reddish colour, but the thin part appeared to have ruptured, but the specimen was unfortunately rather damaged in removal, it was difficult to say that rupture occurred before death or that they were removed. 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 double pouch on each side of it having a thick free edge. The whole aneurism was about 70 inches in circumference.

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 and obstruction of the bowels.
from which she suffered previously. She had had no children and 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 had shortness 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 noticed that on inspection of the chest there was visible a pulsating, expansible tumour on the left side of the sternum and moving up and down slightly. It extended from the upper border of the 2nd to the upper border of the 6th rib. It was very tender on palpation and pulsation was felt to the more died at its upper part, the pulsation extended outward as far as the
ipple line. It slowly 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 3rd space of the nipple line.

On auscultation there was heard a systolic murmur over the tumour and a very faint diastolic. The heart sounds were muffled in the aortic area. That made no loud sound was heard there, but the 2nd sound was accentuated over the tumour and in the mitral area. A systolic murmur could be heard down the sternum and in the mitral area. The heart sounds could be heard all over the back of the chest especially over the lower part of the left scapula.

There was no difference in volume over the back of the chest or
The breath sounds of the left base were noted to be jerky, louder than on the right. The pupils were equal but somewhat dilated. The urine was normal.

She complained of attacks of severe pain passing from the temple round under the left axilla to the scalp - sometimes also on the right side. The attacks were brought on by coughing or laughing, but also came spontaneously. During the attacks the face was flushed and I noticed that the left pupil was larger than the right. This was also occasionally when she was free from pain.

She was kept at rest on a low diet for six weeks during which time the swelling became much less prominent, but the pulsation seemed more diffuse. While thus at rest she had mox
pain than she had while setting about. I found that small doses of nitroglycerine (1/2 of 1% sol.) relieved the pain for a time, also
and Amyl nitrite in doses of 1/4 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 of the first third. In both of these cases the expansile
nature of the pulsation and 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, it 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 and not the 2nd space would suggest a weakness of the wall of the sac at 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 infra)

The 2 radial tracings show very
little difference on the 2 sides (the any difference being slightly more tension on the left side) which would point to the whole tranverse portion of the arch being more affected, the origin of the innominate involved. The fact that pulsation was visible in the right infra-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 tranverse arch, but as a negative symptom is not of much value. Then again the fact that pulsation could be felt over the 12th rib points to descending
Aorta being affected, as well as the symptom of pain down the left arm favours this view, pointing to pressure on the intercostal—humeral nerve. The conclusion therefore is that aneurism involves the transverse portion of the aortic arch and the first part of the descending aorta.

In the case of Lord (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 lateral tracing.*

* The right palmar flexion also shows signs of unusual modification which would point to innominate being involved to some extent tho' the tumour be chiefly beyond it.
Case. The absence of visible pulsation in the left supraclavicular region is against aneurism of the Common Carotid or left subclavian. The fact that the pulsation in the tumor travelled visibly from right to left is strongly in favour of aneurism of the transverse aortic 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 the aortic arch or aorta dilated. 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 is tumor would be an abnormal origin of the left subclavian from the ascending aorta.
with aneurisms, 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 readings in aneurisms, there is a point which I think worthy of consideration, 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 and sharp as if an obstruction were suddenly overcome (this was observed only over a small area). In the other cases the sounds were described as being jerky, or it would perhaps be more accurate to say interrupted. 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 branch 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 and 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 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 (lith.), alcoholism, constipation, spasm, lead poisoning, strain.

In connection with syphilis which has long been regarded as a most important factor in the production of aneurysm, it is of interest to note Dr. J. Oliver's observation in his book on "pulse-syphilis" (pp. 374) where he says he has found that syphilis greatly diminished or abolished the posterior changes in pulse calibre, for which he concludes that it has an extensive effect on the wall of the vessel.

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
permanently. Muscular strain causes a temporary increase in pulse frequency, and probably, by far the most frequent immediate cause of aneurysm. Suppose a vessel with dilated walls and 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, this, none of my cases noticed this. When there is only a weakened vessel wall, frequent muscular strain would furnish the additional factor, but the production of an aneurysm under such circumstances would probably be more gradual than where permanent tension exists as well. Prof. Thiene used to say that in some cases at least, aneurysm might be regarded as a natural safety-valve. Where the increase
of tension is due to deficient elasticity of the vessels, this is easy to understand that an aneurism may make up for the want of expansion in the arteries. Moreover an aneurism of any size would tend to equalize the pressure at the commencement of the pulse wave when it is highest, and thus diminish the risk of hæmorrhage which is the chief 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 hæmorrhage.

We come now to the effect of an aneurism on the pulse as shown by tracing the value of these as aids to diagnosis and prognosis. The usual tracing shown in textbooks as diagnostic aneurismatic 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 & obliteration of 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. Smith, 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 or a marked elastic or tidal wave. The tracing over the external
Carotid beyond it, when compared with that taken over the left. Ext.

2nd artery shows well delayed of the pulse wave, the line of ascent forming a curve almost an angle at 8 o'clock, i.e., 9 o'clock. The tidal wave or elastic elevation (Landor) is more marked. Of shorter duration than on the left, showing, lower tension. In all these facts 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

[Graph]

Tracing 6

[Graph]

Tracing 7

[Graph]

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 obliteration of the secondary wave.

Thus the weaker and more expansible the wall of the sac, the weaker will the pulse wave become; beyond it, approach a simple curve. On the other hand, the stronger the sac wall and the less its expansibility, the less will it affect the pulse wave beyond. In, I take it, if we may suppose such a thing, if a purely rigid aneurism could 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 Lynch (Tran EXTRA 172). I do not think such tricuspid could be obtained if the sac wall were thinner and 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 thru the aneurysm at all, but the tension would be lowered somewhat at the site of the aneurysm. 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 remain) the greater the aneurysm 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 D. 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 and 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 contains in the state of contraction, and thus it acts as a sort of reservoir.

From what has been said it follows that a bounding of the pulse wave is an index of the size of an aneurism or 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. Upon consecutive examinations the wave became more curved, it would indicate a giving of the wall, an increase in size of the sac. This sign may be of considerable prognostic importance. As an example of this, if the following tracing be compared with No. 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 the earlier one (No. 3), from which I gather that the patient had not improved but lost ground. The increased pain points to the same conclusion.

Tracing 8

BOND W.R. 3.09.5 59 and 29

Tracing 9

BOND W.R. 3.09.5 59 and 29
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. 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 regurgitation may in part account for this.
We may have seen something from these tracings which exhibit some of the alteration caused by aortic regurgitation, which co-existed. The presence of aortic regurgitation may thus completely destroy the value of the tracing as an index to the existence or condition of an aneurysm; on the other hand, an aneurysm 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. D. Byron Bramwell in his "Studies in Clinical Medicine" p 117 gives a tracing taken from an aneurysmal tumour with a cardio-gram where a similar small wave occurred, which he thinks due to the auricular systole. I have not obtained it in any tracings taken
over aneurismatic tumors.

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, and Weichert in his 'Medical Diagnosis' p. 249, gives a diagram of the 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 aneurismatic 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 illustrates this well.

Now what we have said we may sum up as follows: conclusions.

1. An Aneurysm may exist without notifying the pulse wave. Absence of notification is a favourable sign pointing to a sound seat wall.

2. Modification may occur in 3 ways

(a) Delay of wave.
(b) Equalization elimination of tension.
(c) Accelerated aneurysm diminishing tension.

3. Rounding of the apex of the curve is an indication of (a) existence of an aneurysm.
(b) The state of its walls.
(c) Size of aneurysm. It is probable that it may occur in large aneurysms. The larger the tension the weaker is well the more marked will be the curve.

4. Obliteration of pulse shows a very large aneurysm.
5. The pulse may therefore aid in diagnosis and 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 aneurysms in the cases of Lynch & Bond are perhaps of more interest than value, as they may be compared with the apex beat from the same case.

Tracing 11 172

...
Curricular wave & the ventricular. It has occurred to me that this peculiarity in the therapist (together with the slowness of the pulse 54 per minute) may be accounted for by pressure on the cardiac nerves.

The following tracings are from the case of Bond, 5 were taken on the same day as the radial tracings 3rd, 15th & 8th (p.29) respectively.

Tracing 14

Tracing 15

Tracing 16

Tracing 17

The latter as compared with the former show diminished cardiac activity but in spite of this we have seen
there were evidences of increase in size of the aneurism (pain more marked tendig of the arm) so these tracings would make the prognosis still more unfavourable, so thence I report I heard of the case after she passed out of my hands was very unfavourable. The cranial tracey no. 16 show a great resemblance to the left radial tracey taken on the same day no. 9 (p. 29).

In tracey 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 aorta.

In conclusion I must say that all these tracings without exception were taken by myself with a Dr. Jevn's physiomograph. I am not aware that this instrument
has been used in this way before as a cardiograph, for an unusual tracing - no heart seen any mentionable tracing beside Dr. B. Bramwell's. I think the tracing shows that the instrument can be used efficiently for this purpose. The apex tracing No. 12 is not very good, but the following shows can be done in this way. Took it from a case of

Tracings 18 + 19.

Initial regurgitation in a girl of 12 whose 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.