CARDIOLYSIS (PRECORIAL THORACOSTOMY) IN HEART DISEASE.

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In the early part of 1905 my friend and colleague the late Thomas Harris asked me to undertake for him the operation of "cardiolysis" in an old-standing case of adhesive mediastino-pericarditis. At that time I had not heard of the operation, which had been introduced by Brauer in 1902, and the only information which we possessed upon the subject was contained in a short note of Brauer's communication to the Heidelberg Congress of Physicians of the latter year. The operation appeared, however, to be so reasonable and to offer such prospects of benefit that I decided to carry it out. In several respects subsequent considerations have shown that details might have been improved upon, and the report which follows has therefore been delayed, not only on account of the early death of my colleague, who was himself a distinguished authority upon the pathology of mediastino-pericarditis, but also in the hope that further experience might render this communication of more value. As, however, four years have gone by without my seeing another case, and as it may be long before another is met with, it appears advisable now to describe a tentative operation which was certainly of benefit in one case, and which presents possibilities of greater value in others.

Adhesive or indurative mediastino-pericarditis is a rare sequel of pericarditis in which the cardiac and parietal layers of the pericardium have become united together, while the parietal layer is again connected by adhesions with the surrounding parts, including that portion of the chest wall which overlies the anterior surface of the heart. The condition, which may follow rheumatic pericarditis, chronic pleurisy, or empyema of the left side, and periostitis of those ribs which lie in relation to the heart, is fully described in Harris's *Indurative Mediastino-Pericarditis* (London, 1895) and in many medical works, so that it is here necessary only to enumerate briefly the more important results of the fixation of the heart to the chest wall which is thus produced.

At every systole the left ventricle is obliged not only to empty itself, but in so doing to drag forcibly upon the continuous adhesions and bands which fix it in all directions to the chest wall, lungs, mediastinum, and diaphragm. It is thus placed at a great mechanical disadvantage, and its muscular power is insufficient for the effort required. The result is seen locally in that with each systole the bony thorax is drawn in, while with each diastole it is thrust out; the ordinary "apex beat" is, in fact, replaced by a forcible rising and falling of the chest wall which obviously demands great effort. As a sequel of this excessive strain the myocardium proves unequal to the work of carrying on the circulation, and there ensue the phenomena of extreme congestion—dyspnoea, bronchitis, pulmonary oedema, cyanosis, congestion and enlargement of the liver and spleen, ascites, jaundice, albuminuria, general anasarca, and ultimately death from cardiac insufficiency. Associated with these conditions there are also usually found great swelling of the veins of the neck, regurgitant pulsation in the more prominent of these, and at times inspiratory swelling of the external jugular; the pulse is often very weak and irregular, and pulsus paradoxus—the pulse becoming smaller during the act of inspiration—is not uncommon.

Rest in bed, with careful dieting and medical treatment, is in these cases usually followed by great improvement,

but as soon as the patient begins to get up and go about symptoms return, and the ultimate issue is probably always fatal.

Brauer's suggestion was based upon the view that the essential factor in the production of this chain of symptoms is the fixation or anchoring of the heart to the bony wall of the thorax, and that if this could be relieved its muscle might regain sufficient power to carry on the needs of the circulation. Such relief can be given by removing that portion of the bony thorax to which the heart is attached, so that any adhesions which remain are connected only with yielding tissues, and Brauer applied the term "cardiolysis" to the operation which was successfully carried out for him by Petersen and Simon. Fourteen cases have now been reported by German physicians and surgeons, and one recently by Poynton and Trotter (*infra*), the results being distinctly encouraging; while our own, which is, so far as the writer knows, the first to have been performed in this country, although not a complete success, shows clearly the practicability and value of the operation.

CASE.

History.

H. W., a lad aged 15, began to suffer in 1900 from shortness of breath and rheumatic pains in the knees. At the end of 1900 he was admitted to Dr. Harris's wards in the Manchester Royal Infirmary with double pleurisy, bronchitis, and general oedema. The area of cardiac dullness was enlarged; the pulse presented marked weakness on inspiration, and the jugular veins showed inspiratory swelling; the liver was enlarged, but without ascites or jaundice; the temperature presented an occasional evening rise; tubercle bacilli were not found in the sputum. From the right chest was removed 28 oz. of clear serous fluid. A few days later ensued an attack of acute pneumonia at the base of the left lung with a long period of remittent pyrexia, but eventually the lad made a fair recovery.

Two years later H. W. was again admitted to the infirmary with symptoms of cardiac weakness, indications of pleural adhesions and thickening on both sides of the chest and ascites. From this time until the beginning of 1905 he was repeatedly an in-patient, with symptoms similar to those already described. On each occasion he underwent temporary improvement in bed, but quickly relapsed on getting up again. In January, 1905, he was again an in-patient, remaining for two months with but little improvement, and Dr. Harris then suggested cardiolysis. The lad refused and returned home, but almost immediately he again became very ill, and in

March, 1905, was admitted to the surgical wards.

At this time he presented marked cyanosis of the face and body, but he had then no oedema of the legs. The veins of the neck expanded greatly on inspiration. The pulse was of low tension, dicrotic, and beating at the rate of 65 to 70 a minute. Cardiac dullness extended from $1\frac{1}{2}$ in. to the right of the sternum almost to the mid-axillary line on the left side. An impulse could be felt behind the fifth left rib almost $1\frac{1}{2}$ in. internal to the mammary line, but there was no visible apex beat, no epigastric pulsation, and no general movement of the chest wall. There were no signs of endocarditis or of valvular disease.

Troublesome cough was associated with a scanty mucoid expectoration which furnished no tubercle bacilli. Dyspnoea was very marked, rendering it almost impossible for him to lie down, but the chest movements were very slight. The base of the left lung presented an extensive area of dullness with weakened breath sounds. Ascites was well marked; the liver extended 2 in. below the costal margin; the urine (sp. gr. 1024) contained albumen; splenic enlargement was not detected. The mental condition was markedly dull and heavy, and was at that time regarded as due to the cardiac trouble.

Operation.

The operation was performed on March 30th, 1905, Dr. A. E. Thompson administering chloroform, and the patient being at first in a semi-recumbent position. The anaesthetic was at first taken well, but before the operation was commenced there was spasm of the respiratory muscles and he became very cyanotic. Under artificial respiration and oxygen he rapidly recovered, and ether and chloroform were then given by the open method

in about equal quantities, after which there was no further trouble.

I made a semilunar incision about 9 in. in length with the centre of its base to the right of the sternum and the centre of the incision an inch internal to and on a line with the left nipple, thus turning over a large flap to the right and exposing a great part of the sternum; this flap contained the origin of the left pectoralis major, and was carried down to the plane of the ribs and intercostal muscles, somewhat free bleeding being arrested. A Gigli's saw was then carefully passed behind the sternum about 1 in. above the line joining the nipples, and the bone was sawn transversely across at this level. The same process was repeated at a line 1 in. below the level of the nipples. With bone forceps the fourth and fifth costal cartilages on the right side were then cut across close to the sternum, and their fellows on the left side were cut across at the costo-chondral junction. There was thus isolated a large square piece of the centre of the sternum with the fourth and fifth left costal cartilages, and this was carefully dissected up from the subjacent pericardium. This process was much more simple than had been anticipated, and there were no dense adhesions. A prominent gland was removed from the anterior mediastinum for purposes of bacteriological diagnosis, but inoculation experiments showed no evidence of tubercle. Haemorrhage being finally and fully arrested, the flap was replaced with a small gauze drain.

The operation caused no shock, and at the end of it the pulse was distinctly stronger than it had been, while the inspiratory swelling of the veins of the neck disappeared.

After-History.

For a few days after operation cough was troublesome, but the cyanosis rapidly improved and the pulse continued to gain strength. On the ninth day the ascites had so far diminished as to lessen the girth of the abdomen by 3 in. There was no difficulty in lying down in bed. At the end of a month the patient was able to get up, and a few days later to walk up and down stairs without trouble.

Six weeks after operation the patient was feeling well and able to go out. Ascites had disappeared, and the dullness at the base of the left chest was much diminished. Cough was hardly at all troublesome. The cardiac dullness was much diminished in extent, reaching from a point just internal to the

left mammary line to half an inch to the right of the sternum. The pulse was regular, steady, and 72 a minute, with no trace of pulsus paradoxus, which had occasionally been observed before operation. Congestion of the face, neck, and chest had already disappeared. The patient and his parents had not seen him so well for years, even after six or eight weeks of confinement to bed in hospital.

Present Condition.

Some time after H. W. left the hospital his mental condition began rapidly to deteriorate, and he was eventually placed in an asylum. I thus lost sight of him until June of the present year, when I had an opportunity of examining him in the Lancashire County Asylum at Winwick; he is quite idiotic and very mischievous, the mental condition being regarded as congenital. He has on the whole good bodily health, but his mischievous tendencies require his being a good deal confined to bed. In January of 1908 he presented some signs of heart failure, and had some jaundice and ascites, which disappeared after rest and paracentesis, and have not returned. Albuminuria has been found occasionally. In the beginning of 1909 he had some temporary dyspnoea and oedema of the feet.

His general appearance was healthy and cheerful, although idiotic. The pulse was 80, and quite regular and normal. There was no venous distension, but the face presented very slight cyanosis. The abdomen was normal, as was the urine. In front of the chest was the prominent gap left by the operation, and the lower end of the sternum had been thrust considerably forwards. The position of the scar with the puckered depression left by the gauze drain are shown in the accompanying sketch taken from a photograph kindly obtained for me by Dr. Rodgers, but the restlessness of the patient made photography difficult. In brief, the physical condition is on the whole satisfactory, and would probably have been more so but for his restless, mischievous, and irresponsible habits.

Before passing to the consideration of certain points raised by the above case it will be convenient briefly to summarize the fifteen operations hitherto reported as "cardiolysis," these being the only cases known to me in which operation upon the thorax has been undertaken with the object of freeing the heart from adhesion to its

Case.	Reporter and Reference.	Operator.	Anaesthetic.	Parts Removed.	Result.	Remarks.
I.	Brauer, Petersen, Simon, <i>Centralbl. f. Chir.</i> , 1903; Supplement, p. 41	Petersen and Simon	Local anaesthesia, chloroform, ether	Ribs and cartilages in front of heart	Doing heavy work 4 years later	These three cases appear to be identical with those referred to by Blauel (<i>Centralbl. f. Chir.</i> , 1907, No. 33) and by Ensgrüber (Dissertation Tübingen, 1907).
II.	Idem	Idem	Ether	Part of sternum and ribs	Great improvement, but died later from broncho-pneumonia	
III.	Idem	Idem	Chloroform and ether	Part of sternum and ribs	Great improvement.	
IV.	Beck, <i>Arch. f. klin. Chir.</i> , 1904, Bd. 73	Beck	Morphine, chloroform, and ether	3rd, 4th, 5th, and 6th costal cartilages and part of ribs with periosteum	In good health after 18 months	These three cases are complicated by the coexistence of tuberculous disease of lungs or pleura and by operations thereon.
V.	Idem	Idem	—	3rd, 4th, 5th, 6th, and 7th cartilages with ribs and periosteum	Improvement, later thoracoplasty for empyema	
VI.	Idem	Idem	—	As in Case IV.	?	
VII.	Treupel, <i>Munch. med. Woch.</i> , Oct. 10th, 1905, p. 1966.	Borkenheimer	?	4th and 5th ribs ...	Some improvement	Symptoms not very typical, but heart large.
VIII.	Schmidt, <i>Deut. med. Woch.</i> , Nov. 16th, 1905, p. 1859.	Lindner	?	4th and 5th ribs from sternal border to anterior axillary line	Marked improvement, working as wagon cleaner	Possibly identical with Case X.
IX.	König, <i>Centralbl. f. Chir.</i> , 1907, No. 27 Umber, <i>Therapie der Gegenwart</i> , 1905, No. 1	König	Morphine, ether and chloroform	2nd, 3rd, 4th, 5th, and 6th cartilages and ribs (8 cm. in all). Periosteum not removed	Immediate relief of heart; great and steady improvement up to 6 months	No cardiac trouble up to death after 2½ years from miliary tubercle.
X.	Meyer-Westfeld, <i>Munch. med. Woch.</i> , 1905, No. 40	Lindner	Chloroform	4th and 5th cartilages and ribs to anterior axillary line	Tedious recovery; ultimate return to work	
XI.	Küttner, <i>Munch. med. Woch.</i> , 1906, No. 28	Küttner	Ether	4th, 5th, and 6th cartilages and ribs, with periosteum as far as anterior axillary line	"Rapid recovery"	
XII.	Danielsen, <i>Beit. zur. klin. Chir.</i> , 1906, Bd. 51	Küttner	Ether	4th, 5th, and 6th cartilages and part of ribs; periosteum removed	Considerable improvement and return to work	
XIII.	Urban, <i>Wien. med. Woch.</i> , 1908, No. 8, p. 395	König	Local; followed by chloroform and oxygen	4th, 5th, and 6th cartilages and ribs; periosteum retained	Very good recovery	
XIV.	Wenckebach, <i>BRITISH MEDICAL JOURNAL</i> , Jan. 12th, 1907, p. 63	Koch	Chloroform	4th, 5th, 6th and 7th cartilages and ribs and left border of sternum	No great improvement	
XV.	Poynton and Trotter, <i>Lancet</i> , June 19th, 1909	Trotter	—	3 or 4 in. of 4th and 5th ribs, leaving posterior periosteum	Some improvement	

bony wall. I have omitted all details as to the symptoms before operation, as the cases are generally of a type similar to our own with marked evidence of cardiac failure, which was not relieved, or was only very temporarily relieved, by complete rest and medical treatment.*

In addition to these 15 cases we have also to note that an operation similar in some respects to Brauer's "cardiolysis," but differing in its objective, has been suggested by Alexander Morison,¹ and carried out for him in two cases by Stabb. Morison holds that in cases of cardiac hypertrophy, as met with in aortic disease and angina pectoris, the heart has not room to exercise its full power of compensation, and that when great enlargement occurs it is confined within the chest, so that on the one hand its power of work is limited, while on the other its action causes pain (angina). He therefore suggested a removal of part of the chest wall in front of the heart, "both when the mere bulk of the organ is the chief feature in the case, and when, as in irremediable mediastinal tumour, the heart is secondarily involved in the neoplastic growth." He refers without detail to one case in which this had been done "with benefit." He also records fully an example of aortic stenosis and regurgitation with marked ventricular hypertrophy and anginoid pain in a lad from whom Stabb removed $4\frac{1}{2}$ in. of the fifth and 5 in. of the sixth rib with their cartilages and periosteum; the general condition and the pain were greatly relieved. In these cases there was no question of dealing with pericardial or extrapericardial adhesions, but they are relevant to the present subject both because the surgical methods are analogous and because the benefit resulting from "cardiolysis" may perhaps be due, in part at least, to giving the heart more room for action, especially in cases such as our own in which marked adhesions are not found.

We are thus provided with a total of 18 cases in which the bony wall of the thorax has been removed in front of the heart for the relief of diseases of that organ, the majority of these having been undertaken on Brauer's theory of relieving adhesions, while two aimed at, and possibly more succeeded in, relieving pressure. The operation is described as "cardiolysis" by those who adopted Brauer's view, while Morison uses the term "thoracostomy," as he does not aim at dealing with adhesions. There seems no reason, however, why the more limited term "cardiolysis" should not be applied to all operations for freeing the action of the heart, whether that be limited by adhesions or by mere want of space, or, if this be objected to, the expression "precordial thoracostomy" might be used to distinguish this from thoracic operations undertaken with other and quite different objects.

As regards this operation it has been conclusively shown not only that it can be performed with reasonable safety, but that in suitable cases it may prove of great value. So far as the question of safety is concerned, we can at present only say that there is no recorded instance of death or any minor untoward result, although certain dangers have to be encountered, especially perhaps in connexion with the anaesthesia.

With regard to the results we may classify the cases as follows: The eight cases in our table numbered I, IV, VIII, IX, X, XI, XII, and XIII appear to have been most satisfactory; four of these certainly returned to their work, and although we have less explicit information in the others the improvement is described as very great or spoken of as "recovery." Cases II, III, V and XV appear also to have been improved very considerably, and to these we may add our own and Morison's second case, making six in which the operation was of very definite value. In some of these, as in our own, and in several tuberculous cases, the results were, however, masked by other diseases. Lastly, there remain three cases, Nos. VI, VII, and XIV, and perhaps also Morison's first case, in which we have no clear evidence of any very material improvement. It is by no means easy in such a summary to assess fairly the amount of benefit in each case, but we can hardly doubt that in the great majority, if not in all, the surgeon and patient have been satisfied with the result. It is also to

be borne in mind that in all these tentative operations the patients have been ill for a very long time, the disease has been far advanced, all other methods of treatment have been fully and fairly tried, and the disturbing question of how far improvement has been due to rest and nursing has been set aside by prolonged care before operation was even contemplated. In the future an early resort to operation before the heart has approached exhaustion may give much better results.

With regard to indications, Brauer and his school lay the greatest stress upon evidence of adhesions to the bony walls of the thorax and especially upon marked diastolic precordial bulging with systolic retraction. The last condition was not present in our own case, which was undertaken before any details of Brauer's work were published, and, of course, before any other cases except Beck's had been reported, and we were, or at any rate I was, unaware of the stress to be laid upon its presence. In our cases it certainly did not appear to myself that the heart was in any way rigidly bound to the chest wall, and I am quite prepared to believe that such benefit as resulted was at least in part due to the mere provision of space for the heart's action. It will, however, perhaps not be expected that a surgeon should express any judgement upon the interesting question raised by Morison beyond saying that the two indications at present recognizable are the release of the heart from a too confined area and its release from adhesions to the chest wall.

On the other hand, it is clear, as emphasized by Umber and others, that it is useless to operate so late that myocardial degeneration has left the heart incapable of recovery, and the best test is probably the fact that temporary recovery ensues with rest and treatment.

In conclusion, I may now refer to certain points in connexion with the operation itself.

The question of anaesthesia presents special difficulties, and has given much anxiety. Beck and König used morphine, chloroform, and ether; Wenckebach and Stabb chloroform; Küttner and Danielsen ether; Petersen and Simon attempted to operate under local anaesthesia, but had to give chloroform and subsequently ether. In our case Thompson employed a mixture of ether and chloroform, and we had a few anxious minutes before the operation was commenced, but no subsequent trouble. The principal difficulty lies in the fact that there is danger on the one hand of syncope under chloroform and on the other of irritation of a congested, inflamed, or tuberculous lung by ether. Personally, we should prefer to mix these anaesthetics, using the open method, relying principally upon chloroform and adding more ether if any sign of cardiac failure demands it. It is also noteworthy that as soon as the chest wall has been opened the heart at once gains power and the pulse improves, so that less ether will be required in the later stages.

The incision has always taken the form of a curve, the soft parts being turned back as a flap. Most operators have turned this flap outwards; Stabb reflected it upwards. In our case it was reflected inwards, as excision of the sternum was our main objective; but in future I should turn it outwards, both because I should not remove much, if any, sternum, and because the flap with its base to the middle line is less well supplied with blood. In our case the congested veins and the section of the terminal branches of the intercostal arteries caused the flap to become very oedematous, with a little sloughing near the drainage aperture, and there can be no doubt that any trace of sepsis would under such conditions have led to disaster.

The extent of bone and cartilage removed has been sufficiently indicated in the table given above. In Brauer's first case this was limited to the ribs; in Simon's cases a part of the sternum was also cut away, and this we carried further, removing the whole of the centre of that bone. In all the later cases ribs and cartilages only have been excised, and this will probably be the course adopted in future. I did not find the firm retrosternal adhesions which I had been led to expect, and had I known more precisely the conditions to be met with I should have spared myself some anxiety by leaving the sternum intact. Possibly, however, in some cases in which after removal of the ribs dense retrosternal adhesions are discovered, it may be well to cut away the left border of the bone. With regard to the amount of

* Venus, in a critical abstract (*Centralblatt für die Grenzgebiete der Medizin und Chirurgie*, vol. XI, 1908, p. 539) enumerates also three cases referred to by Hlauek, and he is followed by Poynton and Trotter (*Lancet*, June 19th, 1909), but these appear to be Brauer's cases.

rib to be removed further experience may guide us; but it would seem reasonable to make the thoracic window of good size, and at least to remove any bone upon which the heart can have a direct impact.

Much stress is laid by several German writers upon the importance of removing all periosteum and perichondrium to prevent bone regeneration, while others emphasize the danger of so doing, and even claim that the posterior periosteum cannot be removed without injury to the pleura, which might, under the conditions, prove a most grave complication (König). Of actual facts to support either contention there are few, if any; but the dread of bone regeneration appears to be at least greatly exaggerated and based on the results of thoracoplasty for empyema, in which the conditions are very different. It would seem to the writer probable that, even if regeneration did tend to occur over the bulging heart, the latter would readily provide space for its action in the thin layers of bone which would first be formed, and that, as the cartilages would in no case regenerate, there would always be an ample gap in the chest wall; while the ends of the ribs, having no attachments, would accommodate themselves to the requirements of the heart. In the case of Umber and König, in which periosteum was not removed, the patient died two and a half years later, and at the *post-mortem* examination it was found that there had been no regeneration except for a few bony spicules. On these grounds I should in future be inclined to adopt König's suggestion—namely, to excise the superficial periosteum, leaving that on the deeper side of the ribs, unless it could be taken away with ease and rapidity; in a case such as Meyer-Westfeld's, in which thick and dense fibrous tissue is found below the chest wall, it is, however, both easy and advisable to remove the posterior periosteum (Umber).

Lastly, it is of essential importance to arrest all hæmorrhage before closing the wound, and it is probably wise to provide a drain for a few days, as the cut surfaces are extensive, and the movements of the heart cause a good deal of mechanical irritation in the flap, and will tend to aggravate the flow of serum.

REFERENCE.

¹ *Lancet*, July 14th, 1908, p. 7.

THE MECHANISM OF CARDIAC PAIN.

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AN investigation of the pain and other sensory disturbances occurring in a series of 50 cases of heart disease has elicited certain facts which seem to have a bearing on the mechanism of production of cardiac pain. The details of these cases are published elsewhere;¹ the purpose of the present article is to emphasize these facts, and to touch upon a few theoretical considerations arising therefrom.

The whole heart, and the aorta as far as the origin of the innominate artery, are developmentally "mesial" organs. Further, the auricles develop from the more caudal part of the primitive heart tube, the ventricles and aorta from the more cephalic part.

From these facts it could be confidently predicted (a) that the cardiac nerves are derived from both sides of the nervous axis; and (b) that the auricles are innervated from segments of the central nervous system caudal (or posterior) to those innervating the ventricles and aorta. The former statement is easily verified by the known facts of anatomy, the cardiac nerves being derived from both vago-spinal accessories, and both right and left sympathetics.

Little seems to be really known, however, as to the exact details of distribution—for example, whether the nerves from the right side supply the right chambers, and vice versa. G. A. Gibson² states that "the left ventricle and its attachments are connected mainly with the left coronary and left deep cardiac plexuses, which, along with the entire superficial cardiac plexus, are in relation with the left nerve centres." He appears to believe, also, that the right chambers are supplied from the right nerves, and, in confirmation, instances a case of failure of the

right heart in which "anginous" symptoms began on that side. On *a priori* grounds, such a scheme of innervation seems highly improbable, as the septation of the heart is a secondary process, having no relation whatever to the bilaterality of the organism.

Statement (b) receives neither verification nor denial from the anatomical textbooks, which contain no reference to the detailed innervation of the separate chambers in terms of the segments of the nervous axis. According to Head,³ the afferent paths from the auricles are connected with the fifth to eighth thoracic segments, those from the ventricles with the first to fifth thoracic, and those from the aortic arch with the third and fourth cervical, and first to fourth thoracic. These statements accord with (b), but they rest on theoretical grounds rather than on anatomical observation. Neither do they represent the whole afferent innervation, as they do not include those of the "bulbar autonomic system" (vago-spinal accessories). There is abundant physiological evidence that these nerves carry afferent cardiac fibres—for example, the "depressor" nerve of the rabbit, and the reflex effects of stimulating the central cut end of the cardiac branches of the vagus in mammals generally. Recently Einthoven⁴ has shown that the peripheral part of the cut vagus exhibits "negative variations" corresponding in frequency with the rate of the heart beat—strong presumptive evidence that the vagus transmits afferent cardiac impulses even during the normal heart rhythm. It is probable that the referred tenderness in the sterno-mastoid, to which Mackenzie⁵ has drawn special attention as a sign often elicitable in patients with failing compensation, is a clinical manifestation of these afferent cardiac impulses in the vago spinal accessories. This tenderness was present in 13 out of the 50 cases examined.

Pain was, or had been, present in 35 cases—that is, 70 per cent. In some it was slight, in others it formed the most striking feature in the clinical picture, being of a severity sufficient to dominate the patient's mode of life. Its distribution varied in different cases, the important point in this connexion being the absence of any definite relation between the site of the pain and the clinical diagnosis of the valvular lesion present. This statement is contrary to the usually expressed views. Thus Head³ describes cardiac pain as of two kinds, (1) local, (2) referred, according to the laws formulated by him and others for the reference of pain in visceral disease. He regards the pain of aortic disease as due to the left ventricle, and as situated over the upper part of the chest, the scapula, and the inner side of the left arm—that is, the territory of the upper thoracic nerves. Similarly, he explains the pain of mitral disease as auricular in origin, and referred to the territory of the middle four thoracic nerves. As regards the mechanism of production, he looks upon the causal factor as being the undue distension of the chamber in question during its diastolic pause. It is on these assumptions, in fact, that he has worked out the innervation of the different chambers as described above.

The discrepancy between Head's account and the findings in the present series of cases can best be exemplified by brief accounts of three cases of undoubted mitral disease in which the distribution of pain was of the type described by him as typically aortic. It is interesting to note that Mackenzie⁶ has described this distribution of pain as occurring in certain cases of mitral stenosis, especially in female patients. He regards it as a sign of exhausted power of contractility of the cardiac muscle.

CASE I.

M. R., female, aged 35. Rheumatic fever one year ago. Since then she has never felt strong, and, at fairly frequent intervals, has had very severe attacks of pain in the front of the chest and radiating down the inner side of the left arm. The pain has been so bad as to cause the patient to pace the room, nursing the arm with the other hand. She noticed, moreover, that these attacks left the arm with a feeling of soreness for some hours afterwards. She was sent up to hospital by her doctor with the tentative diagnosis of angina pectoris. (She never exhibited the immobility or "the fear of impending death" characteristic of the severe form of angina.)

Physical Signs.—Apex beat in fifth left space, just outside the nipple line; impulse fairly well localized, but not very strong. At the apex there is a double murmur, presystolic and systolic, and the second sound can be heard. At the base the second sound is rather accentuated to the left of the sternum; both sounds are weak to the right. The pulse is rather irregular and the liver cannot be felt.