

On some of the causes and effects of valvular disease of the heart : being the Croonian lectures of the Royal College of Physicians for 1865 / by Thomas B. Peacock.

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ON
SOME OF THE CAUSES AND EFFECTS
OF
VALVULAR DISEASE OF THE HEART.



ON
SOME OF THE CAUSES AND EFFECTS
OF
VALVULAR DISEASE OF THE
HEART:

BEING

THE CROONIAN LECTURES OF THE ROYAL COLLEGE
OF PHYSICIANS FOR 1865.

BY

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THE FOLLOWING LECTURES,

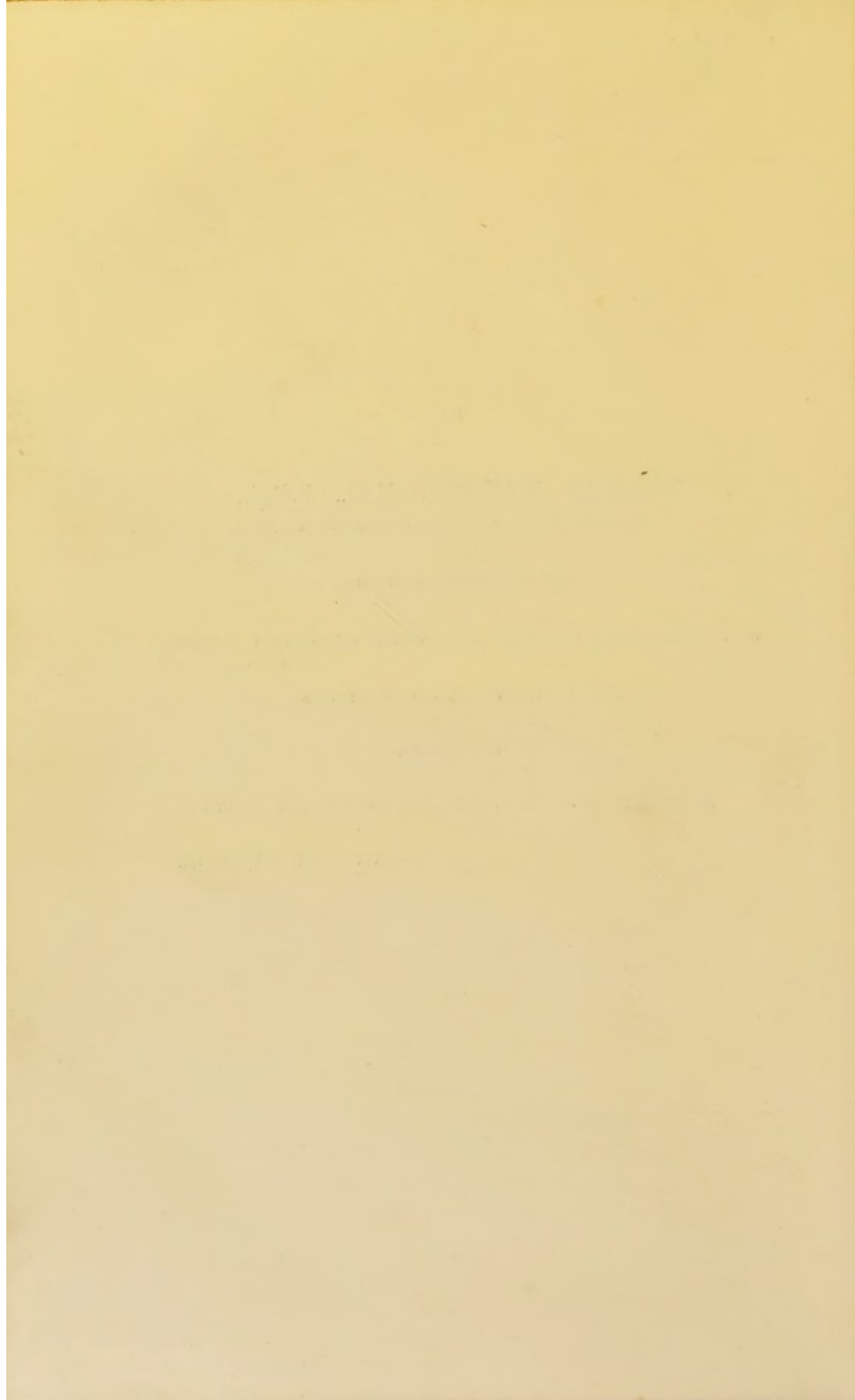
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ERRATA.

Page 7, line 14, for *action* read *column*.

Page 71, line 16, for *diseases* read *disease*.

Page 86, line 27, for *arises* read *arose*.

LECTURE I.

IN adopting for the subject of the lectures which I now commence, a branch of Cardiac Pathology—a subject which has before been so fully and ably treated of in this theatre—I think it right briefly to explain the reasons which have induced me to make this selection. I have long thought that of late years our attention has been too exclusively directed to the influences of inflammatory affections in laying the foundations of cardiac diseases in after-life. The observations of M. Bouillaud, Dr. Hope, Dr. Latham, Dr. Taylor, and the President of the College, showing the frequency of inflammatory affections of the peri- and endo-cardium in cases of acute rheumatism, and the well-known result of such attacks, in too many instances, in organic disease of the heart, have in some degree concentrated our attention too exclusively upon cases so originating, and withdrawn our notice from the operation of causes which, in other instances—a small proportion only, it may be—give rise to disease. It is to the influence of these causes that I now propose to claim the consideration of the College—a consideration which I cannot but think may lead to some modification of the ordinarily received opinions.

In the table exhibited, I have put down the various causes

which give rise to valvular disease and the effects which they severally produce.

Causes of Valvular Disease or Defect.

1. Malformation of valves, arterial and auriculo- ventricular	} giving rise to	{ Regurgitation, Obstruction, or Obstruction and Regur- gitation.
2. Injuries of valves, arterial and auriculo- ventricular; imme- diate and gradual	} " "	{ Regurgitation, with or without Obstruction.
3. Alterations in capacity of orifices and cavities	} " "	{ Regurgitation from ero- sion or maladjustment.
4. Inflammatory affec- tions, chiefly rheu- matic, acute and chronic	} " "	{ Obstruction, Regurgitation, or Obstruction and Regur- gitation.

Of these different causes of disease, however, I only propose to treat of the three first;—the fourth has been so fully illustrated as neither to require nor admit of further elucidation on my part.

I. Malformation as a cause of disease.

First among the causes of valvular disease not originating in inflammation, I have placed malformation of the valves. This is a subject to which my attention has for some years been directed, and in 1853 I communicated to the "Edinburgh Monthly Journal" a short paper, explaining the mode in which I conceived the defective conformation of the aortic valves predisposed to disease in after-life. Since that time I have been led to extend the views then expressed, and to regard the malformation of the auriculo-ventricular valves as being also occasionally the sources of disease.

I need scarcely remind the members of the College that

the semilunar valves, at the origin of the aorta and pulmonary artery, may be originally either too many or too few in number. The mode in which the valvular apparatus is developed we do not know, but it seems probable that each segment is originally composed of two portions, more or less completely divided, which subsequently become blended together. Thus when the number of valves is in excess, the condition is, I believe, always due to the occurrence of supernumerary valves, which are only partially separated from some of the other segments, so as apparently to indicate an imperfect blending of the curtains together. If this be correct, the excess in the number of the valves is not the result of redundant development, but of an arrest of the proper process of growth. We thus frequently meet with four semilunar valves, sometimes with five, and on the view suggested there is no reason why there should not be six, though I have never in any instance seen that number.

When the number of the valves is defective there may be only two segments, or the apparatus may consist of a single imperfectly-formed curtain. In cases of this description I conceive that the defect is due to a process altogether different from that which occasions the former condition. It seems most probable that the segments are originally correctly formed, but, during foetal life, the angles and contiguous sides of two or more of the valves become adherent, and the band of membrane which indicates the line of union subsequently becomes atrophied and more or less completely disappears. Thus, when only two curtains are found they are generally of very unequal size; the upper or arterial surface of the larger fold is marked by a membranous ridge, extending from the edge of the valve to the wall

of the artery, and the lower or ventricular side by a corresponding shallow groove. Generally also the attached margin of the valve displays some remains of the natural convex form of the two separate segments of which it was originally composed.

When all the segments are blended together, the apparatus is in the form of a kind of diaphragm, stretched across the orifice, with an aperture in the centre, and with three fræna or ridges on the arterial, and the same number of grooves on the ventricular surface. The membrane is also generally more or less protruded forwards in the course of the artery, so as to give to the aperture a funnel shape.*

These changes are found both at the aortic and pulmonic orifices; but the protrusion of the valves is generally most marked at the latter, probably from the right ventricle being the most powerful during foetal life, when the membrane is the most extensible.

The conditions described I believe to be the result of intra-uterine disease, though other explanations have been given of them. It has been supposed that when there are only two valves, one with a curtain much larger than the other, that the angles of attachment of one of the valves may have been torn down from accident. A very cursory consideration will, however, show that this supposition cannot explain the occurrence of the condition in most of the cases in which

* The different forms of malformation of the valves have been described and figured by Meckel, *De Cordis ab.*, Table II. figs. 2 and 3; by Hope and Carswell, and by myself in the *Path. Trans.* iii. p. 289. In this place a form of defective development is described, which is, I believe, unique. See Dr. Bennett's case in museum of St. Thomas's. For references to other examples, see Otto's *Path. Anat.*, by South.

it is found. Injuries of the kind referred to do occur, but they are certainly very rare; and, when they are sustained, they give rise to symptoms of a most serious character and which cannot be overlooked; whereas the condition described is often found in persons who have never presented any signs of cardiac disease or sustained any serious injury. Blending of the valves, precisely similar in every respect to that described, is also met with in the bodies of young children and infants, and in connexion with other deviations from the natural process of development, which conclusively prove their intra-uterine origin. Thus the pulmonic valves are often found united together in cases in which the septum of the ventricles is imperfect, or where the foramen ovale is unclosed, and the ductus arteriosus still pervious—conditions which clearly point to the existence of obstruction at the pulmonic orifice during foetal life.*

It may, therefore, safely be concluded that these changes are congenital. It may also be inferred that the diseased processes upon which they depend are in their nature precisely similar to those which give rise to thickening and

* For confirmation of these remarks see the author's work on "Malformations of the Heart, &c." p. 114. Cases are here mentioned in which two of the valves were blended together in a monstrous foetus, which had never breathed; a case of fusion is also described by M. Obre, in an infant six weeks old. I also found the condition in an infant of the same age, sent to me by Dr. Ingram, and in one of six months, exhibited at the Path. Soc. by Dr. Quain. See also preparations in the Victoria Park Hospital Museum, B. 15, and 14, from boys, seven and fifteen years of age, who were killed accidentally. In B 17 the aorta is given off from pulmonary artery, and there is fusion of aortic valves, in a child æt. ten weeks. See also *Bullet. de la Soc. Anat.* 29^{me} année, 1854, p. 119, M. Klein; in a child five and a half years old.

adhesions of the valves in after life ; for we know that inflammatory affections of the peri- and endo-cardium do occur in the fœtus.* The effects of recent inflammation are frequently found in cases in which the valves present some of those conditions regarded as congenital. If the changes described originate in inflammation during intra-uterine life, the subsequent recurrence of the same diseased process is not at all remarkable.

The first description of irregular development which has been mentioned, that in which the valves are in excess, does not appear necessarily to interfere with their functions. The second, however, that in which one or more of the segments are blended together, is probably always a source of more or less obstruction, and in a considerable proportion of cases lays the foundation of serious disease. The mode and extent to which it interferes with the function of the valves varies, however, as to whether the fusion affects only two of the segments or includes all the three valves.

1. It is evident that, when there are only two semi-lunar valves, at either of the two arterial orifices, and one of the curtains is considerably larger than the other, the larger curtain, not being adequately supported in its middle, must have a tendency to become stretched, and to fall below the level of the other segments, so as incompletely to close the orifice during the diastole of the ventricle. Regurgitation must thus be permitted ; and the regurgitant

* Billaud found adhesions between the layers of pericardium, evidently of old date, in an infant which only lived two days ; and Dr. Mossman, at Berlin, met with a recent endo-carditis of the mitral and tricuspid valves in a child which only survived birth twenty hours. — Arch. Gén. de Med., cinquième série, tom. v. p. 80, 1855.

current once established, will have a tendency to turn back the edge of the valve so as to aggravate the evil. Not only, however, has the united curtain a tendency to yield in this way, but the portion at which the union has taken place, being generally thickened and indurated, is less extensible than the rest of the segment, and so does not adequately expand with the progress of growth. The edge, therefore, is, as it were, held back in that situation, and, when the valves are closed, a space is left through which regurgitation takes place.

These changes occur in the most marked degree at the aortic orifice, and are there also of the greatest importance, from the great pressure to which the valves are subjected by the action of blood in the systemic arteries. They are further liable to be aggravated by the occurrence of acute and chronic inflammation, leading to thickening and induration of the defective curtains, or to destruction of a portion of the edges or sacs, so as to cause great obstruction or give rise to very serious insufficiency.

2. In the form of defect in which the whole of the curtains are blended together and a kind of septum, perforated by a larger or smaller opening, is stretched across the aperture, more or less obstruction to the flow of blood from the ventricle is necessarily occasioned. Generally also the opening which exists is incapable of being closed, so that regurgitation from the artery into the ventricle also occurs. Not only, however, is this condition always a source of some obstruction, but the valves very generally become greatly thickened and indurated with the progress of life, so as to become rigid and unyielding, and to reduce the opening to a very small size. It is, however, very remarkable that most

aggravated disease of this kind may exist during many years without being productive of any symptoms of cardiac defect. Such symptoms only occurring when, from the gradual process of enlargement, the ventricle becomes no longer capable of overcoming the obstacle to the circulation; when the general power of the patient is prostrated by some cause, entirely independent of the cardiac defect; or when, from subsequent disease, the original source of obstruction has been seriously augmented.

It will be seen from the remarks which have been made, that I regard the first form of defective development of the valves as generally giving rise to incompetency, more rarely to obstruction; while the second more especially becomes a source of obstruction, and less frequently gives rise to incompetency.

Of the production of these several forms of disease in the modes described, I proceed briefly to quote some examples.

One of the best instances of the occurrence of insufficiency from the blending of two of the segments to which I can refer, is presented by a preparation contained in the Museum of the Royal College of Surgeons, which has been described by John Hunter in his manuscript catalogue, and figured by Dr. Baillie in his plates. The account of the case is as follows:—"Description of the body of a man who had been very strong, but was greatly emaciated.—The lungs were sound. On examining the valves of the aorta, I found that there had been only two, instead of three, and that one of them had a kind of frænum or cross-bar, attaching its middle to the side of the artery. The valves were very much diseased, and had become thick and strong, by which they did not meet entirely or by their edges." This con-

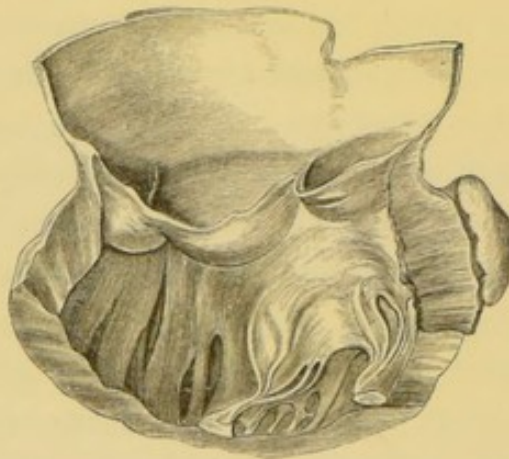
dition he suspected to be due to original defect; and it is evident, on examining the specimen, that the imperfect meeting of the segments mentioned by John Hunter was caused in the way which has been described.

CASE I.—The most characteristic example of this form of valvular disease which has occurred in my own practice was in a man, forty years of age, a patient at the Royal General Dispensary, some years ago. At the time he became ill he was acting as a porter, but had previously been a sailor. He had rheumatic fever eleven years before his death, but entirely recovered and continued well till two years before. He was seriously ill for only three months, and his illness was characterized by the usual symptoms of disease of the heart, difficulty of breathing, palpitation, cough, and expectoration, which was occasionally bloody, and dropsical symptoms. A double murmur was heard at the base of the heart, and there was also a systolic murmur at the apex. The pulse was intermittent. The urine was not at first albuminous, but subsequently became so. The dropsical symptoms were aggravated, his breathing was extremely difficult, and he became semi-comatose and died.

On examination after death the lungs were found congested and oedematous. The pericardium was universally attached by old cellular adhesions. The heart weighed $16\frac{1}{2}$ oz. avoirdupois. The mitral valve was thickened and rigid, and the orifice had a capacity of 42 lines (3.729 E. I.). The aortic aperture was of large size, measuring 45 lines (3.996 E. I.) in circumference. The right and posterior-semilunar segments were united together so as to form one curtain, which was of much larger size than the other valve. On

the aortic side of the larger segment there was a distinct ridge or septum passing from the edge of the valve to the attached margin, and there can be no doubt that this condition of the valves was congenital. (Fig. 1.) The united

FIG. 1.



fold was considerably thickened and rigid, and must have been a source of obstruction to the flow of blood into the aorta; while from the want of support to the edge of the valve and the imperfect expansion of the fold at the seat of union, a triangular aperture was left when the valves came together, which allowed of free regurgitation from the artery into the ventricle. The left ventricle was considerably enlarged, and its walls increased in width, measuring at the thickest part 10 lines ($\cdot 88$ E. I.) The right ventricle also was dilated and hypertrophied, the walls being 4 lines ($\cdot 35$ E. I.) in thickness.

In this case also it is probable, from the symptoms and signs which had been observed during life, that the left auriculo-ventricular aperture had been imperfectly closed, and that this depended upon the maladjustment of the

mitral valves. The aperture was of natural size relatively to the ventricle, and the curtains were not sufficiently diseased to have caused incompetency.

In instances of this kind the edge of the united curtain often becomes everted by the action of the regurgitant current of blood, as has been before explained. A specimen displaying this condition was exhibited at the Pathological Society by Mr. Obré of which I have preserved a drawing. The specimen was removed from the body of a young man, eighteen years of age, who had never had rheumatism, and was quite well till three months before death. The symptoms suddenly came on when he was walking up a hill. The heart weighed $14\frac{1}{2}$ oz. The cavity of the left ventricle was greatly enlarged, and the walls an inch in thickness at the base. The union involved the right and posterior segments, and the edge of the united curtain was turned down, and had become adherent to the endocardium below. The edges of the valves were studded with vegetations.*

The cases in which the malformed valves become the seat of subsequent disease, either acute or chronic, giving rise either to rapid breaking down or to more slow induration and thickening, are of more common occurrence than those which I have last named.

CASE II.—In 1855 I exhibited a characteristic example of this condition at the Pathological Society. The subject of the disease was a man forty-five years of age, who had never had rheumatism, or sustained any serious injury, and who was only ill for about three months before his death. He suffered

* Path. Trans., iv. p. 99.

from palpitation, difficulty of breathing, cough and expectoration, but was not dropsical. The pulse was characteristically of the regurgitant character, the præcordial dull space was considerably increased in extent; and a loud systolic murmur was audible over the whole of the region of the heart, but most distinctly in the course of the aorta and at the base, where also a feeble diastolic murmur was heard.

The heart weighed 20 oz. avoirdupois. The aortic orifice was considerably reduced in capacity, admitting only of the passage of a ball, measuring 24 French lines (2·314 E. I.) in circumference, or being about a third less than natural. (Fig. 2.) This contraction was due to the blending together

FIG. 2.



of the angles and sides of two of the semilunar curtains; and the valves were much thickened and indurated, and in places displayed masses of bone, so as to form an imperfect osseous ring, which must have been both a source of great obstruction and have prevented the complete closure of the aperture. The left ventricle was of very large size, but the walls were not increased in thickness. The right ventricle and both auricles were dilated.*

* Path. Trans., vii. p. 88.

Cases in which the whole of the semilunar valves, at either of the ventriculo-arterial orifices, are blended together are perhaps of more common occurrence than those in which the fusion occupies only two of the segments. The aortic valves are also more frequently the seat of the disease than the pulmonic, in cases in which the conformation of the heart is otherwise natural, though certainly not in those in which there are other serious deviations from the natural process of development in the organ.

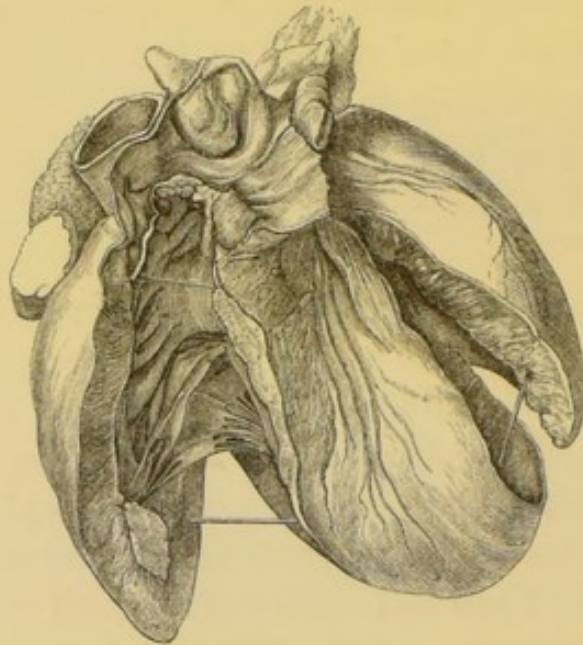
The following case, however, affords an example of the rarer form of defect:—

CASE III.*—A young man, twenty-three years of age, came under my notice at the Victoria Park Hospital, in November, 1855. He then stated that he had been ill eighteen months, and that his indisposition commenced with spitting of blood, cough, and expectoration, and he had had two other attacks of hæmoptysis between the first and the time at which I saw him. He had the usual symptoms and signs of commencing consumption, with laryngeal complication, a husky voice, and abortive cough. In addition to these symptoms, a loud systolic murmur was heard at the upper part of the sternum, and especially at the left side of that bone. In the beginning of 1856 he was taken with cerebral symptoms, became convulsed and comatose, and died in February. On examination after death the lungs were found extensively tuberculous, and the larynx was ulcerated about the chordæ vocales. The valves of the pulmonary artery

* Path. Trans., x. 1858-9, p. 107. Victoria Park Hospital Museum, B 18.

were extremely diseased, the curtains being entirely blended together and much thickened, and the membrane so formed pushed forward into the trunk of the vessel, so as to form a funnel-shaped opening, only 15 French lines (1·332 E. I.) in circumference. (Fig. 3.) The appearance of the valvular

FIG. 3.



apparatus was similar to what has been before described, there being three fræna or bands on the arterial side, indicating the lines of adhesion. The artery itself had a capacity of 33 French lines (2·93 E. I.) The heart weighed $9\frac{3}{4}$ oz. avoirdupois, and except being hypertrophied and somewhat dilated, especially in the right ventricle, where the walls measured 4 lines (·355 E. I.) in thickness, was free from disease. The foramen ovale and ductus arteriosus were closed. Cases of this kind, in which the pulmonic valves are extensively diseased, without there being other serious defects in the conformation of the heart, are of very rare occurrence.

I have myself met with only the case reported, and in 1858 was only able to refer to seven other cases placed on record in this country, France, and Germany. It has been doubted whether the condition is to be regarded as due to disease during foetal life or occurring after birth; but the exact similarity of the affection of the valves to that which very often coexists with other undoubted malformations, is in favour of the former supposition; and the correctness of this opinion is, I think, established by a case published in the "Pathological Transactions," by Dr. Ogle. The subject of the case was a female, fourteen years of age, who had been affected with difficulty of breathing for some years, and during childhood suffered from palpitation and difficulty of breathing on making any active exertion. She had never had rheumatic fever. The case is further interesting from the circumstance that the aortic valves were similarly affected, so that if the intra-uterine disease of the one orifice be admitted, that of the other must necessarily be conceded.*

In the following cases, the obstruction was situated at the aortic orifice:—

CASE IV.—A boy of feeble mind, eighteen years of age, came under my care at the Victoria Park Hospital, in 1849. He had never had rheumatism or any other serious disease, and was regarded as in his usual health, when he went to see some houses which had been burnt down, where several persons had perished; while there, his feelings were so worked upon, by hearing a bystander describe the fire, that he was seized with

* Path. Trans., v. 1853-54, p. 69.

a fit, and was never afterwards well. He suffered from palpitation and difficulty of breathing, and when I saw him nine months after, he presented the usual symptoms and signs of obstructive and regurgitant disease of the aortic valves. He was also subject after his first attack to occasional epileptic seizures. He survived for about three years, but continued to suffer as before. On examination after death, the aortic valves were found to present a very aggravated example of recent disease, superinduced upon an original malformation. The whole of the segments were very greatly thickened and indurated, and in places studded with cretaceous deposit. The contiguous sides of the left and posterior curtains were adherent together throughout, and the left valve was also in part united to the others. The two united valves, therefore, formed a large curtain, only partially separated from the other valve. In the larger fold there were two ulcerated openings, of which the edges were studded with nodules of lymph. The proper aperture of the vessel, notwithstanding the rigidity of the valves, could be closed; but through the two openings free regurgitation took place from the artery into the ventricle. The heart weighed 28 oz. avoirdupois, and the walls of the left ventricle were thickened and the cavity enlarged. A mass of bony or cretaceous matter adhered in one part to the endocardium. The auricles were much dilated. There was a white patch on the pericardium, but no other signs of disease.*

CASE V.—In the next case which I shall refer to, the

* Path. Trans., iii. p. 75.

aortic valves were malformed and very extensively thickened and indurated, forming hard bony masses, and must for long have been the cause of very serious obstruction to the flow of blood from the ventricle. They were also incapable of entirely closing the aperture, so that an opening remained which must have allowed of free regurgitation during the diastole; yet the patient did not appear to be otherwise than in sound health till he suffered from what was supposed to be a severe bilious attack followed by two paroxysms of ague. This case occurred in 1857, in a gentleman forty years of age, who had been ill for three weeks when I first saw him.* He ascribed his illness to having taken cold; but he was living in a district in which ague was very prevalent at the time. When first seen he had difficulty of breathing and some œdema of the lower extremities. The pulse was excessively irritable and vanished rapidly under the finger; a loud systolic murmur was heard at the base of the heart, and the second sound was inaudible. He rapidly became excessively prostrated, the dropsical symptoms increased, he had urgent difficulty of breathing, and died a week after I visited him. The examination after death showed the heart to be of very large size and its walls thick. The valves at the aortic orifice were blended together so as to form a septum stretched across the aperture, and perforated by a triangular opening in the centre. The valves were thick, rough, and studded with ossific deposit. (Fig. 4.) The gentleman had not been observed by his friends to be short-breathed on exertion. He was somewhat irregular in his habits, had been addicted to hunting and horse exercise, and had never had rheumatism

* Path. Trans., ix. p. 61.

or any other serious disease. He had, however, been very delicate in early life.

FIG. 4.



In the two following cases the obstruction, owing to valvular malformation and subsequent disease, was extreme; and beneath the valves there were small apertures leading into aneurismal sacs, situated just above the bases of the ventricles :—

CASE VI.—The subject of one of these was a man twenty-seven years of age, who was under my care at St. Thomas's, in 1860.* He died shortly after I saw him, and no satisfactory history of his illness was obtained; but while in the hospital he had urgent dyspnœa, laboured under cough and expectoration, and was anasarcaous. The heart weighed 17 oz. The left auriculo-ventricular aperture was contracted, admitting only of the passage of a ball 24 French lines (2·131 E. I.) in circumference, and the mitral valve was considerably thickened. The aortic aperture was also decidedly contracted from adhesion and thickening of the valves, and had the same capacity as the auriculo-ven-

* Path. Trans. xii. p. 75.

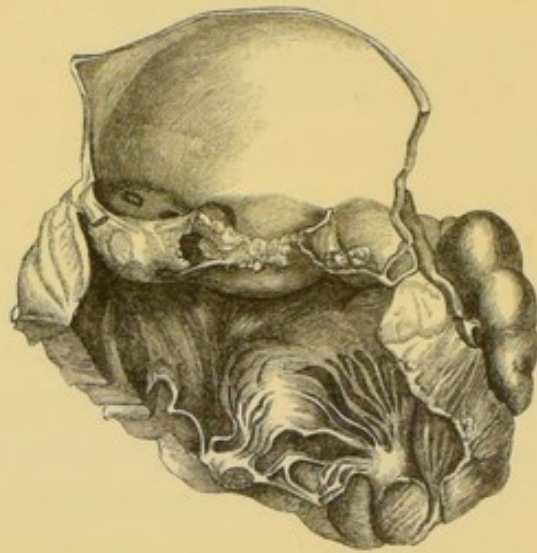
tricular aperture. Below the angle of attachment of the left and posterior aortic segments there was a small opening which led into an aneurismal cavity, capable of lodging a nut, situated between the auricular appendage and the external coat of the aorta. The left ventricle was considerably hypertrophied and dilated, the cavity of the left auricle was especially large, and the cavities on the right side were also dilated.

CASE VII.—The other case occurred in a man forty years of age, an ironfounder, under my care at St. Thomas's, in 1851. He had never suffered from any serious illness, and was in good health till twelve weeks before his death, when he had pain and swelling of the legs, probably rheumatic, followed by dropsical symptoms. While in the hospital he suffered from urgent difficulty of breathing, cough, and expectoration, latterly mixed with blood, and was anasarcaous. The urine was of low specific gravity and albuminous. A loud systolic murmur was heard in the præcordia, and was distinct at the level of the nipple, between that body and the sternum, and over the upper part of the sternum, but was only feebly audible below the mamma; the pulse was quick and feeble, and there was great prostration of strength.

After death the aortic valves were found extensively diseased, the whole of the segments being blended together, and much thickened and indurated, and in places ossified. A hard mass was thus formed, which projected into the mouth of the vessel and greatly reduced the dimensions of the orifice. Beneath the posterior segment a small opening led into a cavity situated in the substance of the septum. A second and larger aperture, situated between the right and posterior valves, led into the same cavity, and from it there existed an

opening into the left sinus of Valsalva, but it was doubtful whether this had existed during life, or was the result of changes after death. If not actually formed during life, it must have been on the eve of taking place. (Figs. 5, 6.) The small aneurism would have lodged a hazel nut. The mitral valve was also thickened and opaque, and had some shreds of lymph adhering to its free fold. The left ventricle was more capacious than

FIG. 5.



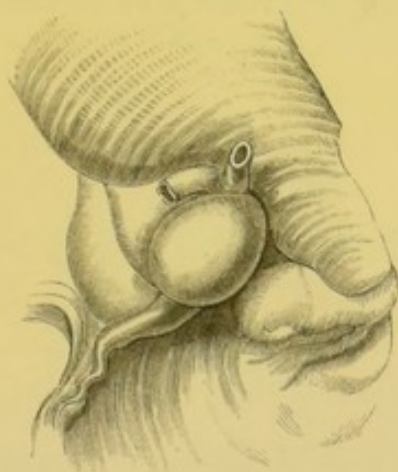
natural, and its walls were somewhat increased in thickness. The left auricle also was enlarged, and its walls much thickened. The right ventricle was hypertrophied and dilated, and the right auricle dilated. The heart weighed 12 oz. avoirdupois.

Cases similar to the two last have been described and figured by Dr. Hope and Dr. Thurnam; and a third, almost precisely identical with the first, occurred some time ago at St. Thomas's, and is described by Dr. Bristowe in the *Pathological Transactions*.

It has before been remarked that in some cases of this description, notwithstanding the extreme thickening and in-

duration of the valves, and the consequent smallness of the orifice, showing that the disease must have been in progress

FIG. 6.



for many years, no symptoms of cardiac affection may have been experienced. The state of the heart may, indeed, only be indicated, as in this instance, by the occurrence of symptoms very shortly before death, or be detected on *post-mortem* examination, when the patient has died from some cause not at all connected with the cardiac defect.

CASE VIII.—A very remarkable instance of this kind fell under my notice some years ago at the Royal Free Hospital. A female, seventy-six years of age, was operated upon by my then colleague, Mr. Gay, for strangulated hernia, and died shortly after the operation. On examination, the heart was found somewhat large for the sex and age of the subject, weighing 10 oz. avoirdupois. The aortic valves were most extensively diseased, two of the curtains being completely blended into one, and the aperture reduced to a mere slit, 10 lines in length ($\cdot 888$ E. I.), while, from the excessive thickening and induration of the curtains, the segments could

only be made to separate to the extent of three or four lines. The surfaces of the valves were rough and irregular, but the remains of the line of attachment of the united curtains were still readily to be traced. (Fig. 7.) In

FIG. 7.



this instance, on careful inquiry, I was assured that the patient had enjoyed good health throughout her life, and was never known to have suffered from rheumatism, or to have had any symptoms of disease of the heart. Indeed, I was told that up to the time of the occurrence of the fatal attack she was in her usual health, was able to go without difficulty to the top of the house in which she resided, and was not known to have suffered from any unusual difficulty of breathing.

Cases more or less closely resembling this have been reported by Corvisart, and one of them is especially noticeable. It occurred in a female, seventy-six years of age, who had always been ailing, and had suffered from symptoms of disease of the heart after her sixty-seventh year. The aortic orifice was reduced by disease of the valves to a mere chink, which only admitted of being opened to the extent of one or two lines, and the mitral valves also were thickened and rigid. Several specimens of similar disease of the valves are contained in the Hunterian Museum, in

one of which John Hunter appears to have hesitated as to whether the disease had originated during foetal life or shortly after birth. Two very remarkable cases of the same kind are also quoted in Dr. Stokes's work "On Diseases of the Heart and Aorta." The first of these occurred in a gentleman of middle age, who up to a few days before his death enjoyed uninterrupted good health, yet Dr. Stokes tells us that "the aortic opening exhibited the most extreme degree of obstruction from ossific deposit that he had ever seen. At first it appeared as if there was no opening, but when examined on the ventricular side, a very small slit was discernible, about four lines ($\cdot 355$ E. I.) in length and one in breadth, through which it was just possible to pass a fine probe." The other case occurred in the practice of Dr. Graves, in a gentleman of fifty-four years of age, who was free from symptoms of disease till six months before his death, when he was suddenly seized while walking up a hill. In this instance the aperture was so greatly reduced in size from the valvular disease that it only admitted of the passage of a fine quill.

In cases of this kind there can be no doubt the changes in the valves must have been slowly progressing for many years, the obstruction occasioned being compensated by the increasing power of the ventricle, so that no symptoms of disease were caused. It may, however, be doubted whether the condition is always of congenital origin ; but when two or more of the valves are found completely united, I think the probability is that the union took place during foetal life.

The auriculo-ventricular valves may also, I believe, be sometimes the seat of malformation, which may lay the foundations of disease in after-life.

The tricuspid valves are occasionally found blended together at their edges, so as to form a kind of membranous septum separating the right auricle and ventricle, and perforated by a larger or smaller aperture generally of a triangular shape, in the centre. This condition is occasionally met with in combination with other deviations from the natural conformation of the heart obviously of congenital origin, as in a case related by Lallemand and Louis.* In other instances it occurs, either alone or in conjunction with a similar fusion of the left auriculo-ventricular or aortic valves, in persons who have been from early life subject to difficulty of breathing or palpitation on any active exertion, and who have never had any of the affections which ordinarily give rise to disease of the heart. In yet other cases, persons in whom this condition of the valves is found may have suffered even severely from rheumatism, but yet that attack may only have aggravated symptoms of some cardiac defect under which they had previously laboured. In cases of this kind we may fairly suspect that the original defect had been of congenital origin, and such suspicion is increased by the well-ascertained fact that the auriculo-ventricular valves may be the seats of disease during foetal life. Dr. Mossman, of Berlin, has reported a case of recent endocarditis of the mitral and tricuspid valves in a child which survived birth only twenty hours, and of which the signs had been observed during life. We know also that both apertures are not very unfrequently found contracted or obliterated in children with malformed hearts.

* I have also described a similar one in the "Pathological Transactions," v. p. 64.

The views which I express have previously been advanced by Mr. Burns, and have received the support of Dr. Farre and Laennec. The former gentleman has described three cases which had fallen under his own notice, in which he thinks that affections of the auriculo-ventricular valves were of congenital origin, and one of them can, I conceive, scarcely be assigned to any other cause. The case was that of a girl, nineteen years of age, who had been extremely delicate from birth, and "subject to pectoral complaints, syncope, and darkness of the surface," and for the last two years of her life the action of the heart was irregular, and she was dropsical. "The tricuspidal valve was rigid, and in places ossified," and the mitral valve "formed a tendinous septum stretched over the opening leading from the auricle into the ventricle." This septum was rigid, and in some places ossified; "it was perforated to the centre by a puckered aperture of a size just sufficient to admit the tip of the little finger. It might aptly enough be compared to the iris perforated by the pupil." This case is quoted by Dr. Farre, in confirmation of Mr. Burns' views, and Laennec refers to a somewhat similar instance of disease which he regarded as the result of changes which had occurred in the foetus. He found "the laminae of the tricuspid valve united together over their extremities, in such a way as to have their points sufficiently free to admit the end of the finger between them. The mitral was precisely in the same state, and contained moreover, within its substance, some small cartilaginous incrustations. The sigmoid valves of the aorta and pulmonary artery were in like manner adherent together for the space of over two lines at the point of meeting. The valves seemed to be no other way diseased,

and the union of the parts was so intimate that the limits of the different valves could not be distinguished."

A somewhat similar case is related by M. Luton in the Bulletin of the Société Anatomique of Paris, for 1858.* The subject of the disease was a female twenty-two years of age, who first presented symptoms of cardiac disease when thirteen years of age, and had never had rheumatism or visceral inflammation. The symptoms arose without any obvious exciting cause. The tricuspid, mitral, and aortic valves were all thickened, and the several apertures were considerably contracted. I have myself met with two cases, in which the aortic and both sets of auriculo-ventricular valves were extensively diseased, and a third in which the changes were chiefly limited to the auriculo-ventricular valves; and in all these I think it probable the affection was of congenital origin, though aggravated during after life.

CASE IX.—The first of these cases occurred in the practice of Mr. E. Pye-Smith, and, by his kindness, I both saw the patient during life and had the opportunity of being present at the examination after death. The subject of the disease was a female, thirty-seven years of age, who was of peculiarly stunted form and feeble mind, and altogether did not appear to be of half that age. She had all her life been very delicate, and for some years suffered from shortness of breath and palpitation of the heart, and was particularly susceptible to cold. Latterly she had œdema of the ankles. She had never had any form of rheumatism. The heart weighed 9 oz. The curtains of the tricuspid and mitral valves were adherent and thickened, and the apertures greatly

* Deuxième Série, tom. iii. p. 497.

contracted. The right auriculo-ventricular opening admitted only of the passage of a ball measuring 21 French lines (1·864 E. I.) in circumference, and the left auriculo-ventricular opening of 24 lines (2·131 E. I.). The aortic valves also were much thickened, and the orifice in consequence contracted. The right auricle was greatly dilated and its walls thickened. The right ventricle also was dilated, and the left auricle and ventricle both enlarged and their walls increased in thickness.

CASE X.—The second case was very similar, except that the patient, a young woman of thirty-two years of age, had had two attacks of acute rheumatism, one thirteen years, the other two years, before her death. She was, however, reported by her friends to have suffered from palpitation of the heart almost from birth, and to have been for many years subject to jugular pulsation, and for the last ten or twelve to syncopic attacks. The symptoms became much aggravated after the first attack of rheumatism, and since that time her breathing had been affected, and she had been livid in the face.

On examination, the right auriculo-ventricular valves adhered intimately together so as to form a septum extended between the two cavities, and with only a triangular aperture of communication, barely capable of admitting the forefinger, or having a circumference of about 15 French lines (1·332 E. I.). The membrane was also considerably thickened. The mitral valves were similarly adherent and thickened, and the aortic to such an extent as to have become incompetent.

CASE XI.—The third case referred to has more recently fallen under my notice. It occurred in a female, eighteen

years of age, who had been delicate all her life, but much more so after an attack of rheumatic fever, which occurred eighteen months before her death. The particulars of the symptoms during life are unavoidably defective, the notes having been mislaid.

After death some white patches were found on the attached pericardium, and there were adhesions between the large vessels and between the two membranes at the apex. The heart weighed $13\frac{1}{2}$ oz. avoirdupois. The left auriculo-ventricular aperture was exceedingly contracted, and the valves were thickened and studded with vegetations at their edges. The tricuspid valves were also extensively adherent together, forming a membranous septum with an oval aperture in the centre. The cavities on both sides were considerably enlarged and their walls increased in thickness.

I am not able to refer to any case of uncombined mitral valvular disease which can be regarded as conclusively supporting the opinion that the lesion is occasionally of intra-uterine origin. I think, however, it is confirmatory of this view, that the most complete cases of union of the valves which are met with occur almost always, if not always, in young persons; and sometimes in those who have never had rheumatic fever, and have been delicate and subject to cardiac symptoms from birth. The case in which the valves were more completely attached and the aperture more remarkably contracted than any other which I have seen, occurred in a boy twelve years of age, who had been ailing all his life, but had never had any serious illness or any rheumatic symptoms. It is, indeed, difficult to suppose that such extensive disease as occurs in some of these cases,

could, if suddenly induced, be compatible with the maintenance of life even for a short time, still less for several years, as is not unfrequently the case in instances of this kind. The remarks made, however, I wish to be regarded rather as suggestions than deliberate assertions, to be confirmed or disproved by future observations.

Writers have described, under the name of atrophy of the valves, a condition which is by no means of unfrequent occurrence, in which portions of the curtains, either of the arterial or auriculo-ventricular valves, are deficient in the fibrous basis of their structure; or in which both membranes are in places entirely wanting. This condition is most frequently seen at the angles and sides of the aortic valves and in the attached curtain of the mitral, and it has been supposed that it is sometimes a cause of insufficiency. Generally, however, I believe that the defect is of very little importance; but when, from dilatation of the orifices or of the cavities of the heart the valves are imperfectly adjusted, in the way to be hereafter described, it may seriously aggravate the evil, and tend to promote the eversion of the edges of the valves so as to give rise to regurgitation.

It has been supposed by most writers on cardiac pathology, and especially by Corvisart and Laennec, that disease of the heart not unfrequently originates in want of just proportion between the size of the ventricles and the capacity of the orifices and vessels leading from them. There can be no doubt that from deviations from the natural process of development such want of proportion may be occasioned. Thus, when the ductus arteriosus is prematurely contracted, the pulmonary artery remains permanently small; and when the portion of the descending aorta, between the origin of the

left subclavian artery and the entrance of the ductus arteriosus, is not fully dilated, the aortic orifice and ascending portion of the aorta are less than natural. If either of these conditions exist to a marked degree at birth, the closure of the foramen ovale or of the ductus arteriosus would be prevented, and the cases would be regarded as malformations. The defects may, however, at that time only be slight, so that the heart may undergo the usual changes; yet there may be sufficient obstruction to the circulation to give rise to disease in after-life. It is apparently in this way that contraction or obliteration of the aorta beyond the origin of the left subclavian artery is occasioned. The narrow or rigid portion of the aorta interferes with the transmission of the blood to the lower parts of the body, the heart acts with increased power to overcome this obstruction, the left ventricle, therefore, becomes enlarged and its walls increased in thickness. The ascending aorta also becomes dilated, while the pressure of the blood in the contracted part causes irritation, the coats become thickened and indurated, not unfrequently fibrinous material is deposited in the canal, and ultimately, as the result of changes occupying a long period, the calibre of the vessel may be entirely obliterated. Of this, as it has been termed, *quasi-malformation*, a considerable number of very remarkable examples has been placed on record. In 1860 I collected and analysed forty instances of the kind, of which ten were examples of entire obstruction, and thirty of more or less contraction. At the present period there are on record about forty-six cases, eleven of the former class, and thirty-five of the latter. With this exception, I doubt whether a congenital want of proportion in the heart and arteries is frequently a source of disease in the circulatory

organs. It seems more probable that the cases of undue smallness of the aortic orifice and of the aorta, which are occasionally seen, originate in irregular growth after birth, in the way suggested by Dr. Barlow, in a paper in the sixth volume of the "Guy's Hospital Reports."* The want of proportion is not, indeed, so far as my observation serves me, between the aortic orifice and left ventricle, but between the right and left sides of the heart, and depends upon the imperfect expansion of the lungs with the progress of growth.

The remarks which have now been made complete what I propose to say in reference to malformation as a cause of subsequent disease of the heart. It remains for me briefly to state the frequency with which I conceive this cause to operate, and to inquire how far we can form a probable opinion of the mode of origin of any given case during life.

On referring to the notes of cases of valvular disease, which have been under my own care and in which I have had the opportunity of examining the heart after death, I find that of twenty-six cases of aortic valvular disease, nine probably originated in malformation of the valves; and of seventeen cases of combined aortic and mitral valvular disease, two probably so originated; or, in other words, of forty-three cases in which the aortic valves were diseased, either alone or in conjunction with the mitral valves, in eleven, or 25·5 per cent., there was malformation of the valves, which probably laid the foundation of the subsequent disease; a proportion which is much larger than would *à priori* have been expected.

In judging, during life, of the likelihood that any given

* 1841, p. 235.

case may have this mode of origin, it might be expected that when the disease originates in malformation it would generally occur in early life. On comparing the cases, however, this supposition does not seem to be correct, or at least, if applicable at all, it is only partially so. Thus it appears that in the cases of aortic valvular disease assigned to malformation, the age of all the patients averaged 42·3 years, and the extremes of ages were eighteen and seventy-six; while the mean age of the patients in whom aortic valvular disease originated in other ways was only slightly greater, or 47·4 years, and the extremes of age were twenty-one and sixty-two. From this calculation the cases originating in immediate injury are excluded. There does not appear to be much difference as to the sex of the patients also in which the disease thus originated. Of twenty-two male patients, in eight the valves were malformed; while in four female patients one displayed the same condition.

The history also will not throw much light upon the special cause which may have given rise to the disease. I believe, however, that when the symptoms and signs of uncomplicated aortic valvular disease manifest themselves in persons who have never had rheumatic fever or other serious illness, and who have never sustained any severe accident, or followed for a long period a laborious occupation, we shall generally be correct in assigning its probable production to malformation of the valves. This inference will be strengthened if the patient be young, or has not attained middle age, before which period the ordinary causes of the disease do not generally operate; and especially if throughout life, or for many years, there have been symptoms of general delicacy and of some cardiac defect; or if the symp-

toms have suddenly occurred, when the patient was apparently in good health, and without being dependent on any obvious cause operating upon the heart, or accompanied by active inflammation; but rather appearing when the patient's strength was prostrated by some general indisposition. Guided chiefly by the latter considerations, I ventured in the instance of the gentleman to whose case I have referred, to suggest that there might possibly be some malformation of the valves, and this surmise proved on post-mortem examination to be correct.

LECTURE II.

IN my last Lecture, I spoke of the cases of valvular disease which originate in malformation ; I now proceed to consider the next series of causes in the list—the Influence of Injuries.

II.—*Injuries as Causes of Valvular Disease or Defect.*

The valves of the heart may be indirectly injured in external accidents, but more generally they give way under violent muscular exertion. The injuries which they sustain may also be immediate, one or more of the valves being torn ; or more gradual, some portion of the apparatus yielding under long-continued straining or pressure. From an early period cardiac pathologists have regarded injuries of the valves as probable causes of disease ; but, so far as I know, the first instances in which the valves were actually shown to have been seriously injured during muscular exertion, are those reported by Corvisart, one of which occurred in his own practice at the early period of the French Revolution ; while the other was subsequently reported by M. Marat. Since that time cases have been placed on record by Bertin and Legendre, Dr. Latham,* Dr. Bence Jones, Dr. Quain,† &c.

* Clinical Lectures.

† Path. Trans. vol. i. p. 63, and "Monthly Journal of Medical Science," vol. vii. (N.S. vol. i.) p. 405.

In 1851, I communicated to the Pathological Society a case of the same kind, which had fallen under my own notice,* and since that time I have met with three other cases, in only one of which, however, was the diagnosis confirmed by post-mortem examination. More recently, specimens of valvular injury have been exhibited at the Pathological Society by Dr. Wilks and Mr. Spanton.

The following are brief notes of the cases which have fallen under my own notice :—

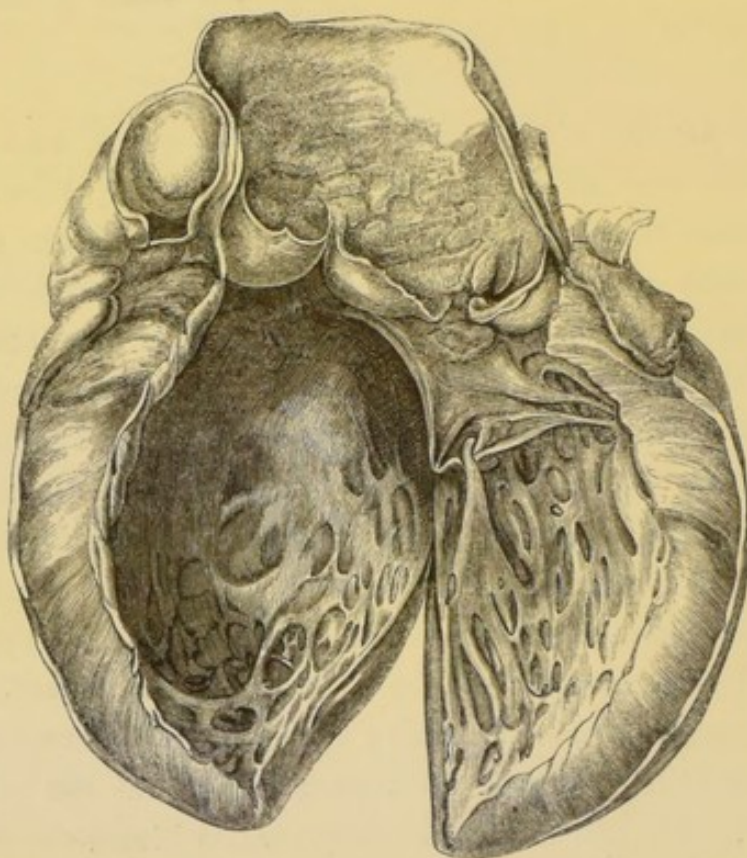
CASE I.—W. C., a sailor, aged thirty-three, first came under my care at St. Thomas's, in November, 1849. He then stated that ten months before he had left Bona on the West Coast of Africa, where he had been for seven weeks, and had suffered from endemic remittent fever. Shortly after sailing, he was directed to go aloft to assist in securing the main royal, and ran up the shrouds, racing against another man. When he reached the cross-trees he was seized with severe pain in the region of the heart, became faint, and gasped for breath as if he was dying. In a few minutes these symptoms subsided, and he was able to do what was required and to return to the deck. He still, however, felt faint, had difficulty of breathing and pain in the chest; and during the remainder of the voyage home was not able to go aloft. He had never had any serious illness except the one named before this occurred.

When he was seen for the first time, he presented the usual symptoms and signs of obstructive and regurgitant

* Path. Trans. vol. iii. p. 71, and "Edin. Monthly Journal," 1852.

disease of the aortic valves, the pulse being characteristic, and a loud double murmur being heard at the base of the heart and in the course of the aorta. He continued to come to me as an out-patient till the spring of 1850, when I lost sight of him, and did not again see him till March of the following year; he then again came to the hospital, and

FIG. 8.



said he had only just landed and had been a voyage to Calcutta and thence to Mauritius and Australia. He had acted as cook during the voyage out, but on the return did his full duty as an able seaman. On examining his heart, I found the physical signs to be the same as before, but in his

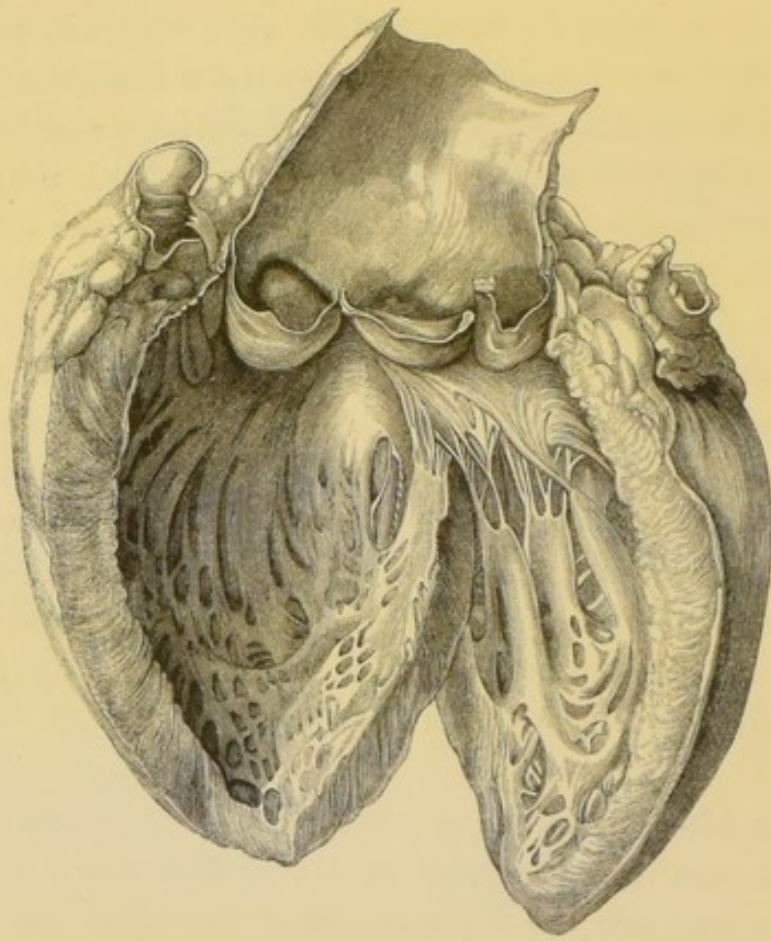
general condition he was much altered for the worse. I admitted him into St. Thomas's, and he died, somewhat suddenly, a few days after.

On examination, the immediate cause of the fatal result was found to be an extravasation of blood upon the surface of the left hemisphere of the brain. The heart was greatly enlarged, and weighed $17\frac{3}{4}$ oz. There was a white patch, about the size of a shilling, upon the surface of the right ventricle, and the remains of more extensive exudation on the auricles, and adhesions between the serous coverings of the large vessels. The aortic valves were extremely incompetent, and this was found to be due to the tearing down of the angles of the left and posterior segments; which, however, were not loose, but still continued attached at the distance of half an inch below the other angles, so that there was a large opening left, by which water freely flowed from the vessel into the ventricle. (Fig. 8.) The valves were all much thickened, and a large plate of bone was found in the coats of the aorta, at the original seat of attachment. There was a small aneurismal dilatation in the free fold of the mitral valve. The left ventricle was greatly dilated and hypertrophied, and the right cavities also were enlarged and the walls thickened.

CASE II.—The second case of injury of the valves which I have met with, occurred in a dock-labourer, thirty-six years of age, who was also a patient of mine at St. Thomas's, in November, 1858. When admitted he was suffering from cardiac symptoms, and stated that he had been suddenly attacked about two months before. He was previously in good health, and had not had rheumatism or any other serious illness.

His attack occurred while he was pulling with other men at a sugar hogshead; his hand slipped and struck him a severe blow on the left side of the chest and he fell backwards. He immediately felt severe pain in the region of the heart and became faint, and in the evening his breath-

FIG. 9.



ing became difficult. These symptoms subsided in a few days but never entirely ceased, and he afterwards got worse till the time at which he was admitted into the hospital. He then had marked symptoms of cardiac disease, a double

murmur was heard over the aortic orifice, the pulse was characteristically regurgitant, and he was dropsical.

He died in December, somewhat more than a month after his admission, or three and a half months from the commencement of his attack.

The heart was found to be greatly enlarged, weighing 23 oz. avoirdupois, and the cavity of the left ventricle was especially dilated and its walls hypertrophied. (Fig. 9.) The left angle of the posterior semilunar segment at the aortic orifice was found to be torn from its attachment, so that it was quite loose and readily admitted of retroversion, allowing free regurgitation from the artery into the ventricle. The valves were all considerably thickened.

CASE III.—The third case occurred in 1855. The subject of the disease was a flyman. He stated that he had been taken suddenly ill three years and a half before. He was off his coach-box when the horse ran away; he endeavoured to overtake it, but after running two or three hundred yards he was suddenly seized with violent pain in the region of the heart, felt faint and fell down, and could not rise for some minutes. Ever after this occurrence the slightest active exertion brought on pain, which extended from the region of the heart to the right shoulder and down the right arm, and with it he became faint and his breathing difficult. Except that he suffered from a winter cough and expectoration, he was quite well before the seizure.

On auscultation, the action of the heart was found to be violent, and the first sound loud, though not attended by a decided murmur, but there was a distinct murmur with the second sound. The pulse was jarring. He died suddenly,

and, as he resided at Brighton, I was not able to get a post-mortem examination, so that the precise nature of the injury is uncertain, though it seems most probable that the aortic valves were in some way torn.

CASE IV.—The last case is one which I have had under my care at St. Thomas's, recently, or in May and June, 1864. The subject of it was a man fifty-two years of age, who came up to town from South Shields where he resided, to obtain relief. He stated that he had suffered from symptoms of disease of the heart for five years, and that he had been suddenly seized when using with great force a draw-knife, in reducing a small spar to be used as the yard of a ship. The knife slipped, and he was immediately seized with pain extending from the region of the heart to each shoulder and down the inside of the arms to the fingers. The pain was so severe that he was compelled to cease working, but he was not faint. Since that time the pain was brought on by the slightest exertion, and it had latterly extended to the back. He had some difficulty of breathing, but no cough or expectoration. He had never spat blood and had not had rheumatic fever. He was pallid and anæmic-looking and had a characteristically regurgitant pulse. On listening over the base of the heart, or at the point of union of the upper and middle third of the sternum, a loud double murmur was heard. At the right side of the upper part of the sternum the systolic murmur was louder and more prolonged, while the diastolic murmur diminished in intensity. On the contrary, to the left of the middle and lower portion of the sternum, the diastolic murmur was more intense and prolonged. The carotid and radial arteries beat

visibly. He remained in the hospital about two months, undergoing a tonic course of treatment, and then returned home very much benefited. In this case there can, I think, be no doubt that the aortic valves had been ruptured, though, as in the last instance, the exact nature of the accident cannot of course be known.

The cases which have been related constitute examples of valvular disease arising in a way which is decidedly rare. In the paper before referred to, I collected together such instances as were then recorded, and they amounted to only eleven in number, and I am now only acquainted with seventeen cases, though it is quite possible that a somewhat larger series might be brought together, had I the leisure to make the requisite search. Dr. Hope, indeed, says he has met with several cases of the kind; but probably they were instances in which valves, being before unsound, gave way under some muscular effort. Dr. Walshe also mentions having seen a case of ruptured valve, but does not explain its nature. Rokitsansky alludes only to laceration of the valves or fleshy columns, as occurring in cases in which the heart is otherwise diseased. Be this however as it may, this cause of valvular disease is certainly rare. This is the more remarkable when, as remarked by Senac, the thinness of the valvular structures is considered.

The cases reported were all instances of injury of the aortic valves, and an analysis of the other instances on record shows, what would, *à priori*, be expected, that the aortic valves, exposed as they are to the pressure of the column of the blood in the arteries, are the parts which are most frequently injured. The other valves are, however, also occasionally ruptured. Of the seventeen cases, the four quoted being included in the

enumeration, the aortic valves were injured in five cases, and probably also in five others; the columns of the mitral valve were ruptured in three cases, and probably in one other; and the columns of the tricuspid valve were torn in three cases.

When the aortic valves are torn, it may be in different parts of their texture. In one of my own cases, the angles of two of the segments were torn, and such was also the case in one of Dr. Quain's. One only of the angles was ruptured in another of my cases; and the attached margin was separated in another of Dr. Quain's. In Dr. Wilks's case the fold of one of the valves was torn from the free edge to the base near the middle; and a specimen figured by Dr. Baillie displays a similar accident, though it is doubtful whether in this instance the valve was previously sound.

In three or four of the cases the patients sustained direct injuries at the time the valves were injured; but it is probable that in all the immediate cause of the rupture of the valves was the violent effort made at the time. In one case the patient had made a long and rapid journey on horseback; two men were pulling or rolling heavy casks; two were running violently; one was rowing; another was striking with a heavy sledge; a third was endeavouring to force open a door; and others were climbing rapidly, endeavouring to leap over a fence, and carrying heavy deals. In others, violent coughing appears to have been the cause of the rupture.

The symptoms by which the occurrence of the injuries is indicated are generally very characteristic. The patients usually suddenly experience pain in the region of the heart, sometimes preceded by a sense of something having given way. The pain generally extends from the præcordia to the spine of the back, and to the shoulders

and arms. Often it becomes very severe, and is attended by difficulty of breathing, oppression at the chest, palpitation, syncope, and sense of impending dissolution. When the aortic valves are injured, syncope appears to be the most marked symptom; while, in injuries of the mitral valve, the patients rather experience sense of oppression at the chest and of suffocation. Spitting of blood also occasionally occurs shortly after the accident, and in two instances of injury of the aortic valves, the patients perceived peculiar sounds extending up the chest and neck and in the ears. In some cases that were seen shortly after the injuries, the physical signs indicating the defect were perceived. The symptoms which have been mentioned appear generally to subside, in some degree, after a longer or shorter period; but the subjects of the injuries are never after wholly free from evidences of cardiac disturbance or capable of following any occupation requiring active muscular exertion, and usually they die in no long time.

The period of death in the different cases of injury of the aortic valves was twenty-one days, three months and a half, thirteen months, two years, twenty-seven months, and three years and a half; and two persons were still surviving after five months, and five years had elapsed since the receipt of the injury. In Dr. Wilks's case, the patient only survived three days; but there were other serious injuries to which the early death was obviously due. In the cases of rupture of the mitral valves, the patients lived nine days and twenty months; and two still survived, eighteen months, and two years, after the occurrence of the accident. Of the cases in which the tricuspid valves were affected, one only occurred during violent muscular exertion; in the second, the patient

was phthisical, and the rupture took place during coughing; while in the third, the muscular structure had undergone the fatty degeneration. The period of death was, in the first case, a hundred and ten hours; in the second, twenty-eight days; and in the third the date of the occurrence of the accident is not recorded. In the first of these cases, though the torn curtain was otherwise sound, there was old disease of the mitral valve, and the tricuspid valves may have been stretched and so rendered more readily lacerable. It is said that ruptures of the fleshy columns of the auriculo-ventricular valves are of not uncommon occurrence in phthisis. I have never however myself met with an instance of the kind; and if such be the case, it is probably owing to the muscular structure having become atrophied. Fatty degeneration of the muscular walls would also predispose to rupture.

The ages of the patients, when recorded in the cases in which the injury involved the aortic valves, were nineteen, twenty-eight, thirty-three, thirty-six, fifty-two, fifty-two, and fifty-four. The cases of mitral injury occurred in persons aged thirty and thirty-four; those of the tricuspid in a young female, whose precise age is not stated; a female of twenty-eight, and a man of forty-one. The subjects of the aortic injury were all males. It thus appears that men in the middle period of life are, as might be expected, the most prone to sustain injuries of this kind.

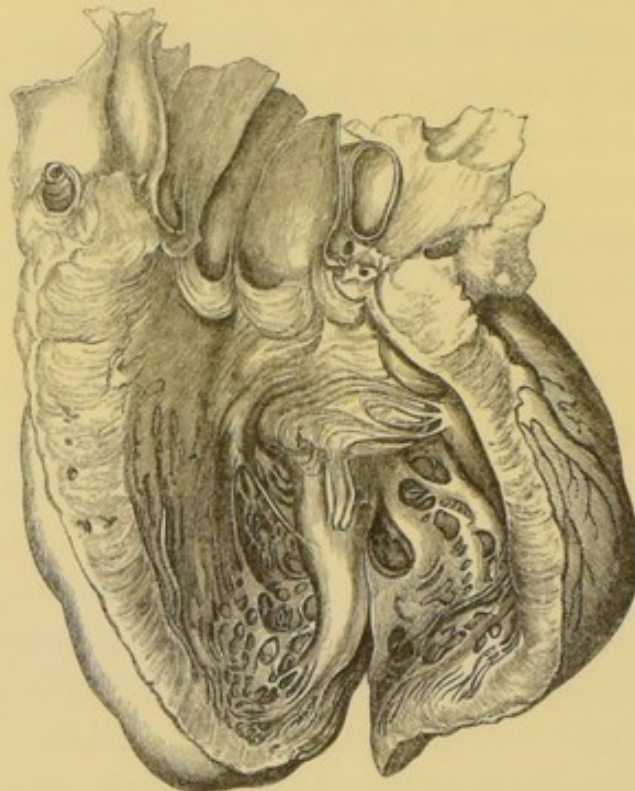
Cases of the kind now referred to are very different from those in which the valves, previously diseased, give way under some slight exertion or shock. Of the latter description, cases have been placed on record by Sandifort and Meckel, Mr. Adams and Dr. Cheyne, Dr. Abercrombie, M. Nicot, Mr. Marson, and others. A specimen figured in one of

Dr. Baillie's plates is contained in the Museum of the Royal College of Surgeons. Dr. Hope has referred to a case probably of this kind. Another case was mentioned by Dr. Elliotson in the Lumleyan Lectures delivered before this College, and is figured in one of the plates affixed to the published volume. In 1860, a case of a similar kind, in which the middle segment of the aortic valves was ruptured at the base, occurred in the practice of Dr. Risdon Bennett at the Victoria Park Hospital, and is related in the *Pathological Transactions*. I have myself recently met with a very characteristic example in a patient at the same hospital.

CASE V.—The subject of the disease was a female, twenty-one years of age, who had been an inmate of the same institution in 1861, suffering from symptoms of mitral valvular disease, the sequence of an attack of rheumatic fever eighteen months before. She was much relieved while under treatment and did not require regular medical attendance afterwards; but continued capable of following her usual occupation of a shoebinder and of going about the house and to the shop for which she worked, till this summer, when she became worse. One afternoon in the autumn she left her home in a cab to go to the Victoria Park Hospital to undergo examination for readmission. She was put down at the garden gate, only a few yards from the door of the waiting-room, and in walking to the latter was violently sick, and rapidly became collapsed and died in a few hours. On examination, the end of one of the fleshy columns to which the free fold of the mitral valve is attached was found torn off, and the curtain was in consequence quite loose. The valve and cords were thickened and rigid, and the ventricle was

large and its walls thick. (Fig. 10.) She had previously had occasional attacks of sickness and vomiting, for which no cause was detected after death.

FIG. 10.



In two of the cases of extreme obstruction at the aortic orifice, certainly of very old date and probably congenital, referred to as reported by Dr. Stokes, the patients first experienced symptoms when taking active exercise. It is therefore probable that the more acute symptoms were excited by some slight injury to the previously diseased valves. Rupture of the tendinous cords of the mitral valve, in cases in which the curtains are seriously diseased, are by no means of unusual occurrence, and they often result from some slight exertion.

The gradual yielding of the curtains and attachments of

the aortic valves from laborious employments long continued, is probably a frequent source of disease; but as the changes in the state of the valves so induced are usually, if not always, combined with alterations in other parts of the heart or in the aorta, it is impossible to quote cases illustrating the occurrence of such changes independently of the others. It has long been observed how frequently disease of the heart, and especially of the aortic valves, occurs in persons who follow laborious occupations, as smiths, strikers and riveters, bricklayers' labourers, hodmen, &c. I have seen several cases of incompetency of the aortic valves in the "along-shore men," as they are called—the men who are employed to load and unload the small coasting vessels at the wharves on the banks of the Thames, the coalwhippers, and the Newgate Market and Deal porters—men who carry very heavy weights upon their shoulders, and often up slanting planks or landings, in which positions the stress upon the aortic valves must be excessive. When in Cornwall, two years ago, I met with a case of incompetency of the aortic valves in a man employed in a somewhat similar way. He was a "coacher," or one of the men who push the trucks containing rock or ore along the tramways at the bottom of the mines,—an operation performed in a stooping position and which requires great force. Many of these occupations are commenced at early periods of life, and must be especially injurious to persons who have not obtained their full vigour. I have frequently known cardiac symptoms occur under these circumstances in young persons employed in laborious occupations, and not unfrequently in girls engaged as servants or nurse-maids, before they had attained their full strength. In some of the cases there is no reason to suppose that the patients have ever

had any inflammatory symptoms, and the cardiac affections are apparently due to overstraining of the valves or to some injury of the muscular structure of the heart.

III.—*Alterations in the Capacity of the Orifices and Cavities of the Heart as Causes of Valvular Defect.*

Dilatation and Contraction of the Aortic Orifice.

The arterial valves may be defective from changes taking place in the valves themselves ; in the capacity of the orifices ; and in the condition of the adjacent cavities and vessels, preventing their being properly adjusted so as completely to close the apertures. Of the first form of disease I do not propose to speak ; it originates in changes of an inflammatory character which have before been fully studied and explained. The last two kinds of defect have not, I think, received the attention which they deserve.

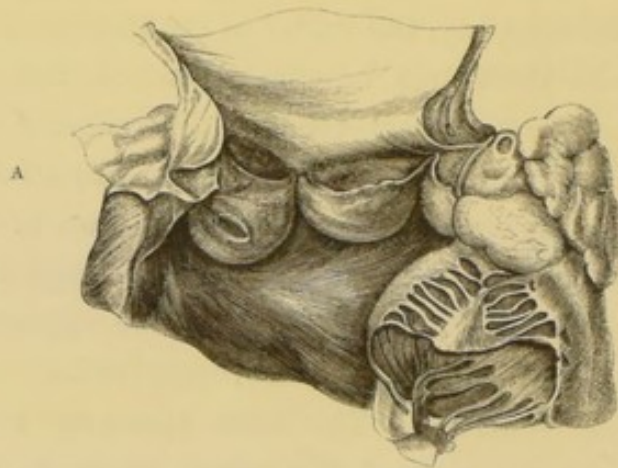
The mode in which alterations in the capacity of the aortic orifice interfere with the efficiency of the valvular apparatus has been well illustrated by Dr. Chevers, in a paper in the "Guy's Hospital Reports." He has shown that the aortic orifice is not to be regarded as a mere opening, but that it is a cylindrical canal, bounded below by the fibrous zone into which the convexities of the semilunar valves are inserted, and above by the angles of attachment of the segments. It has thus a depth of about six lines ; the lower portion being in connexion with the muscular structure of the left ventricle, the upper with the origin of the aorta. The lower portion of the canal is somewhat wider than the upper, and either extremity may be dilated or contracted without involving the other. In the strictly healthy state, the centres of the

semilunar segments should be nearly, if not quite, at the same level as the angles, and the valves should, when closed, come in contact for a space of about two lines at their sides. With changes in the capacity of the inlet and outlet of the aortic passage, the extent of contact may, however, be either considerably increased or lessened, and these changes influence to a marked degree the efficiency of the apparatus. If the ventricular portion of the orifice be dilated, either alone or in conjunction with dilatation of the ventricle, or relatively from contraction of the arterial portion, the sacs or sinuses of the valves become expanded, from the pressure of the column of blood in the aorta falling more directly upon them; if, on the contrary, the outlet of the passage be dilated or the angles of the valves become stretched, the curtains drop below their proper level, the sacs are rendered shallow, and the segments have their spaces of contact diminished. In the former case the tendency is to breaking down of the curtains at their most dependent parts, in the latter to retroversion of their edges; in either case the apparatus becomes incompetent and allows of regurgitation from the aorta into the ventricle. The same tendency to breaking down of the curtains of the valves arises in cases of dilatation of the sinuses of Valsalva, as illustrated by a preparation in the Hunterian Museum. It is in this way that the incompetency of the aortic valves, with which we are all familiar as the result of dilatation of the ascending aorta, from obstruction by an aneurism or otherwise at a more distant part, is probably brought about.

CASE I.—A very characteristic example of the first form of defect described by Dr. Chevers, fell under my notice

at St. Thomas's Hospital, in 1850, in a female thirty-three years of age. She stated that she had been first attacked with the symptoms of cardiac disorder when in an advanced stage of pregnancy, six months before she came to me, and that she had never had rheumatic fever or any other serious ailment. She complained of palpitation, great difficulty of breathing, and severe pain in the epigastrium, extending thence to the spine and down the left arm. A loud systolic murmur was heard over the whole of the upper part of the sternum ; and this was succeeded by an imperfect second sound, ter-

FIG. 11.



A. The expanded valve, with one of the apertures in its fold.

minated by a feeble diastolic murmur, most distinct towards the lower part of the sternum. She improved while under treatment, and left the hospital. Some months after I again saw her, and she died very shortly after. The heart was of somewhat large size, the left ventricle, in particular, being hypertrophied and dilated; the aortic orifice was considerably contracted. (Fig. 11.) The contraction was situated at the outlet, and was due to a deposit of atheromatous matter ex-

ternal to the lining membrane. The outlet of the ventricle measured only twenty-two lines (1.953 E. I.); but the inlet was also very small, having a capacity of only thirty-one lines (2.753 E. I.), the average capacity being in females thirty-four lines. The semilunar valves were all diseased, but the right segment much more extensively than the others. It was considerably expanded, and at the most dependent part had a large opening in its curtain which allowed of free regurgitation.

Of the opposite condition, that in which the outlet of the orifice is dilated, I possess several characteristic specimens, and it is doubtless of frequent occurrence. In the following case the heart displayed other important defects, and one of the aortic valves had its edge retroverted, apparently in consequence of the dilatation of the outlet in conjunction with general enlargement of the aorta.

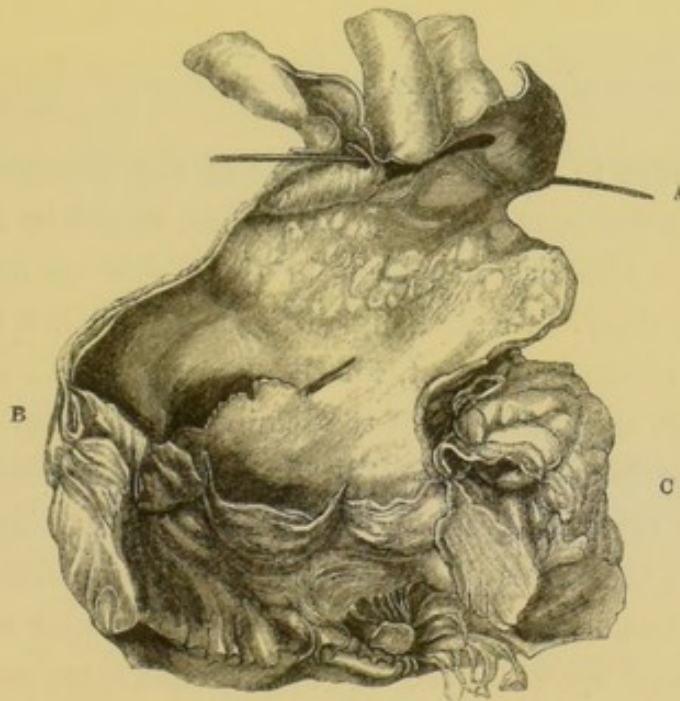
CASE II.—G. S., aged forty-three, a fireman of a steam-boat, was admitted, under my care, at St. Thomas's, in June, 1860. He then stated that he had been ill for four months, and ascribed his attack to cold. He had never had rheumatic fever or any other serious illness or any severe accident, before his seizure. He complained of great dyspnœa, had a troublesome cough, and experienced pain across the lower part of the chest; the abdomen and lower extremities were distended with fluid and the urine contained albumen; the pulse had a jarring regurgitant beat; the cardiac dulness was considerably increased in extent; and a marked musical murmur was heard with the diastole at the base. At the apex there was a systolic murmur of an entirely different note, which was audible towards the left axilla and at the lower angle of the left scapula, but

was scarcely, if at all, heard to the right of the upper part of the sternum. It was inferred that there was regurgitation without obstruction at the aortic orifice, together with regurgitation through the left auriculo-ventricular aperture. Shortly after he was admitted, he presented marked signs of purpura hæmorrhagica, having epistaxis and passing blood by stool and in the urine. After death, the pericardium was found to be healthy; the heart was of very large size, weighing 21 oz. avoirdupois; the ascending aorta and the aortic orifice were dilated, and the edge of the posterior semilunar valve was retroverted and hung loosely into the ventricle, so as to have freely allowed of regurgitation from the aorta into the ventricle during the diastole. The cordæ tendineæ of the left side of the mitral valve had also given way, so that the angle of the valve was quite unattached, and must have allowed of free regurgitation from the ventricle into the left auricle with the systole. There were vegetations both on the edges of the retroverted valve and about the mitral. The left ventricle was considerably hypertrophied and dilated, and the left auricle and right ventricle and auricle were enlarged. The aorta, though dilated, was not otherwise materially diseased.

A specimen (Victoria Park Hospital Museum, preparation C 29) of dissecting aneurism, arising from rupture of the internal coats of the aorta at the origin of the arteria innominata, affords also a good example of retroversion of the valves dependent on enlargement of the outlet of the ventricle in conjunction with dilatation of the ascending aorta. It occurred in a man forty-four years of age, who had been under my care for some time before the occurrence of the dissecting aneurism, suffering under characteristic symptoms of obstruc-

tive and regurgitant disease of the aortic valves. The case proved fatal, not by the bursting of the dissecting aneurism, but by a fresh rupture of all the coats of the ascending aorta by which the blood escaped into the cavity of the pericardium. The case is more fully reported in the "Monthly Journal of Medical Science for 1849." In this drawing (Fig. 12), the loose attachment of the folds of the left and posterior semilunar segments, so as to allow of the retroversion of their edges, is well shown.

FIG. 12.



- A. The original rupture, giving rise to the separation of the tunics.
- B. The rupture which involved the whole of the coats, and allowed of the escape of blood into the cavity of the pericardium.
- C. The semilunar segments which admitted of retroversion.

Changes similar to those now described as occurring at the aortic orifice, may exist at the auriculo-ventricular apertures. The valves may be thickened, shrivelled and con-

tracted, so as not to be able to close the orifice, though it retains its natural capacity; the aperture may be enlarged, so that the valves, though more or less increased in size, may be incapable of covering it; and while the orifice is of proper capacity and the valves free from disease, the complete adaptation of the segments may be prevented by alterations in the size of the left ventricle.

For the reason before assigned I shall not further allude to the diseased condition of the valves themselves, but shall confine my remarks to the two latter conditions.

Dilatation of the Left Auriculo-ventricular Aperture.

The extent to which the capacity of the auriculo-ventricular apertures may vary, is greater than would be supposed by any one who has not been in the habit of accurately measuring them. These changes of capacity are not, however, generally of much moment, for the curtains of the auriculo-ventricular, as indeed also of the semilunar valves, are capable of great expansion, so as still to occlude the orifices, even when the capacity greatly exceeds the natural size. It is only when the valves do not expand in corresponding degree to the dilatation of the orifices, or when valvular disease is superinduced upon the original defect, that symptoms of incompetency manifest themselves. This condition has been supposed to be of very rare occurrence, and there can be no doubt that it is so; yet probably every pathologist has occasionally met with cases of mitral valvular incompetency, due to dilatation of the auriculo-ventricular aperture.

The following cases afford examples of this kind, either with or without valvular disease :—

CASE III.—J. A., aged sixty-one, came under my care about three months after the commencement of his illness, and then told me that previous to his attack he had enjoyed good health. He complained of the usual cardiac symptoms, had great difficulty of breathing, and the lower extremities were œdematous; the præcordial dull space was considerably extended, the action of the heart was somewhat irregular, and a low but distinct musical murmur was heard with the systole at the apex. The second sound was nowhere audible. He continued under my care for two months, and steadily got worse. On examination, the pericardium contained some small amount of fluid but was otherwise healthy. The whole of the cavities of the heart were dilated and distended with blood. The dilatation of the left ventricle was extreme and was attended by thinning of the walls, especially at the apex, which was large and rounded. The aortic valves were natural, except that the fibrous zone at their convex edges was in places somewhat ossified. The mitral valve was slightly thickened and displayed an atheromatous patch upon the free fold, but was not indurated. The aperture was, however, considerably enlarged, and the valves were obviously incapable of closing it.

CASE IV.—The subject of the next case was a girl, aged fifteen, who was a patient at the Victoria Park Hospital in 1859. She had had an attack of rheumatic fever six years before, and had suffered from cardiac symptoms for four years. She had severe dyspnœa, cough, and expectoration, and some œdema of the face and lower extremities. The præcordial region was very prominent, the dulness on percussion was increased in extent, and the pulsation of the heart was widely diffused. The pulse was very irregular; a loud sys-

toxic murmur was heard over the whole præcordia, but was most intense below the nipple; there was also a double murmur heard at the base. She was greatly improved by her residence in the hospital and went out; but shortly after was taken with an attack of diarrhœa and sickness, returned to the hospital, and died in a few days.

The pericardium was entirely adherent by old cellular attachments. The heart was greatly hypertrophied, and weighed, with the adherent pericardium, 25 oz. avoirdupois. The left ventricle was greatly hypertrophied and dilated. The aortic valves were much thickened, and one of the segments fell down below the level of the others, so as to allow of free regurgitation. The auriculo-ventricular aperture was considerably dilated, and from this cause, combined with thickening of the valves, it was evident that the passage must have been very imperfectly closed during the systole of the ventricle. The left auricle and the pulmonary artery were much enlarged, and the right ventricle and auricle hypertrophied and dilated. The aortic aperture admitted a ball measuring 36 French lines (3.197 E. I.) in circumference; the pulmonary orifice, 33 (2.93 E. I.); the left auriculo-ventricular aperture, 54 (4.795 E. I.); the right auriculo-ventricular, 45 (3.996 E. I.).*

In these cases, though the left auriculo-ventricular orifice was dilated, the incompetency of the valves was also in some degree due to the curtains being diseased, and in the last instances the aortic valves also were incompetent. In the following case the defect in the heart consisted almost entirely in enlargement of the left auriculo-ventricular aperture.

* Path. Trans. xi. p. 43.

CASE V.—The subject of this case was a girl of nine years of age, who had always been delicate, but much more so since suffering from hooping-cough, at the age of four or five. Three years before her death she had chorea from which she readily recovered; and continued tolerably well till fourteen months before, when she had a severe attack of influenza. She afterwards began to suffer from palpitation, dyspnœa, and other symptoms of cardiac disease. The præcordia was unduly prominent, the dull space extended, a purring tremor was distinctly felt, and a loud systolic murmur was heard over a limited space at the apex. She died about a year after I first saw her. The pericardium adhered to the heart by two or three old cellular attachments. The heart weighed $10\frac{1}{2}$ oz. The left ventricle was enlarged, and its walls increased in thickness, but the valves did not display any material disease. The left auriculo-ventricular aperture was greatly dilated, so that it exceeded in capacity any of the other orifices, and the valves were clearly incapable of entirely closing it. The left auricle was considerably enlarged, and its lining membrane much thickened and indurated. The right ventricle and auricle were also dilated. The dimensions of the aortic, pulmonic, mitral, and tricuspid apertures were respectively—

30 lines	2·664 English inches.
33 „	2·93 „
45 „	3·996 „
and 36 „	3·197 „

Incompetency of the left auriculo-ventricular valves from dilatation of the aperture, has been made the subject of a paper, by Dr. McDowell, in the Dublin “Journal of Medical

Science," for 1852;* and he has shown that this condition not unfrequently occurs in connexion with passive dilatation of the left ventricle. He further illustrates the symptoms and signs which are so produced, and shows that they correspond very closely with those of obstructive and regurgitant disease of the same passage. The cases which I have related confirm his views, as regards the similarity of the effects of the two conditions; but in cases of obstructive disease, the pulmonary and visceral congestions are generally more marked than in cases of simple regurgitation, and the murmur heard in the usual situation is often of a to-and-fro character.

Mal-adjustment of the Left Auriculo-ventricular Valves.

Incompetency of the auriculo-ventricular valves from mal-adjustment, is probably of more frequent occurrence than imperfection from dilatation of the apertures. Mr. Wilkinson King some years ago pointed out that when the right ventricle becomes considerably dilated, the tricuspid valve ceases to be capable of completely closing the opening. This imperfect closure he supposed to be beneficial in cases where there was great obstruction at the left auriculo-ventricular aperture or in the lungs, by allowing of reflux from the right ventricle into the systemic veins, and so lessening the stress on the lungs. With this idea he applied to the condition, and, with some truth, the term of "*safety-valve function*." The corresponding effect of dilatation of the left ventricle in preventing the perfect closure of the left auriculo-ventricular aperture, has, however, only recently

* "Dublin Quarterly Journal of Medical Science," vol. xiv. p. 352.

been noticed by pathologists. The first writer who alluded to it was, I believe, Dr. Gairdner, of Glasgow,* and more recently Dr. Bristowe has published a memoir on the subject.†

Probably most practitioners have met with cases in which during life there have been symptoms and signs of mitral defect, but after death the valves have been found free from disease and the aperture retaining its natural capacity. Several cases of the kind have at different times fallen under my own notice, and I was formerly much puzzled to account for them. On the supposition that the valves are in such instances imperfectly adjusted, their explanation is, however, easy. I believe that in all cases of the kind, the left ventricle is considerably dilated and usually much altered in shape, being broader at the apex than is natural. The valves and tendinous cords are often much stretched, and the fleshy columns are considerably reduced in size, and, sometimes, are almost entirely absent, being blended with the enlarged ventricular walls. The left auricle is generally dilated, as in cases of ordinary mitral regurgitation; the lungs, also, are engorged and are not unfrequently the seat of apoplectic extravasation; and the right ventricle and auricle are enlarged and their walls thicker than natural. There is, perhaps, in the animal frame no more beautiful example of the adaptation of structure to the function to be accomplished than is afforded by the auriculo-ventricular valves. The insertion of the cords into the fleshy columns, instead of directly into the muscular walls, is apparently not

* "Edinburgh Monthly Journal," 1856.

† "British and Foreign Med. Chir. Rev.," xxviii., 1861, p. 215.

to give greater power of resistance to the pressure of the blood during the systole, but to furnish a means of shortening the attachments of the curtains, when, with the contraction of the ventricle, the walls are more closely approximated. Were it not for this arrangement, the free fold of the mitral, for instance, would fall back towards the auricle during the systole, and the two curtains not being properly adjusted, the blood would flow into the auricular cavity. By the action of the muscular columns, however, the cords are drawn upon as the parietes of the ventricle approximate, and the curtains are kept in apposition and tightly stretched across the aperture, so as effectually to close it. It is, I think, clear, that when the ventricle becomes enlarged, unless the cords and columns undergo a proportionate alteration so that their just relations are maintained, the perfect adaptation of the curtains will be interfered with, and the free fold of the mitral will be held down or allowed to fall back, and the aperture be so kept more or less open.

I have already, when relating a case of aortic valvular incompetency dependent on malformation, mentioned that in addition to the signs indicative of that condition, there was a systolic murmur heard at the apex. This being combined with great difficulty of breathing, cough, bloody expectoration, signs of bronchitis and œdema of the lungs, jugular pulsation, and general dropsy, was referred to mitral incompetency ; yet, on examination after death, no material disease of the left auriculo-ventricular valves was found. The aperture also retained its natural dimensions, measuring only forty-two lines in circumference. The tendinous cords were, however, relatively short and thick, and the aperture had

probably not been completely closed from mal-adjustment of the curtains.

The following cases afford instances of the same condition :—

CASE VI.—M. H., a married woman, 22 years of age, was under my care at St. Thomas's, in 1858, for difficulty of breathing, palpitation, and dropsical symptoms, which she stated had commenced eight months before ; but the full history of her illness was not ascertained. Her complexion was sallow, and she had an icteroid tinging of the conjunctivæ ; a systolic murmur was heard over the whole præcordia but was most intense at the apex. She was very anasarcaous but the urine was not albuminous. She died after having had a severe attack of difficulty of breathing, followed by fainting and convulsions. On examination, the pericardium was found healthy, though containing a small amount of fluid. The heart weighed $16\frac{1}{2}$ oz. avoirdupois. The valves were free from disease, but the left ventricle was dilated, and the right ventricle hypertrophied and dilated. The lungs were congested and œdematous.

In the next case, the left auriculo-ventricular aperture was disproportionately large relative to the other openings ; but the dilatation was not apparently sufficient to explain the symptoms and signs of incompetency which were noticed during life.

CASE VII.—J. B., aged fifty-six, formerly intemperate, but enjoying good health till two years before, was a patient under my care at St. Thomas's, in 1858. He had then been more severely ill for three months, and complained of

a severe cough with hoarseness, expectoration, and pain in the chest and difficulty of breathing. There was œdema of the face and extremities, and the urine was albuminous and of low specific gravity. A harsh systolic murmur was heard at the apex.

On examination after death, the pericardium was healthy. The heart weighed 16 oz.; the left ventricle was considerably increased in size, and its walls were thicker than natural; the apex was large and rounded, and contained much clot. All the valves were healthy in texture, and those of the aorta were completely competent, but the tendinous cords of the mitral were much stretched, and the valves had probably not been properly adjusted, so that the aperture had been imperfectly closed. The left auricle and the right ventricle were much dilated and hypertrophied. The lungs were congested and œdematous, and at the posterior and inferior parts consolidated.

The dimensions of the different orifices were as follow :—

The aortic,	40 French lines,	3·552 English inches.
„ pulmonic,	38 „	3·374 „
„ mitral,	57 „	5·062 „
„ tricuspid,	63 „	5·594 „

In the following case, which has more recently occurred, the heart was free from any valvular disease, and the different apertures had their natural dimensions :—

CASE VIII.—R. M. W., æt. fifty-six, was under my care at St. Thomas's, in 1863. He stated that for twenty years he had been subject to gout, and that being a plasterer he had been much exposed to cold and damp. He had been

working in a new building and took cold, and had been suffering from cough, expectoration, difficulty of breathing, oppression at the chest, and swelling of the lower extremities.

When admitted he was anasaralous, and the urine was albuminous, of low specific gravity and scanty in quantity; the pulse was feeble and irregular. A harsh, systolic murmur was heard at the apex and thence towards the left axilla, and this murmur was heard during the whole of the month that he was in the hospital; he had also great difficulty of breathing, with pains in the chest, signs of bronchitis and œdema of the lungs, and gout in the extremities. He died exhausted. On post-mortem examination, the heart was found to weigh $18\frac{3}{4}$ oz. avoirdupois. The enlargement occupied both sides, but was most marked on the left, that ventricle being both hypertrophied and dilated. The cavity was 51 French lines (4.592 E. I.) in length, and the walls 8 lines (.71 E. I.) in width at the thickest part. The aortic and mitral valves displayed some patches of atheroma but were not materially diseased, and the apertures though generally capacious retained their natural relations.

The aortic measured 38 French lines, 3.374 English inches.

„	pulmonic	. .	39	„	3.463	„
„	mitral	. .	42	„	3.729	„
„	tricuspid	. .	57	„	5.062	„

In a case which I saw in 1862 with Mr. Hutchinson and Dr. Hughlings Jackson, in which the heart was very greatly enlarged, the left auriculo-ventricular aperture was probably not properly closed from mal-adjustment of the valves, but as no murmur had been heard during life, the case cannot be mentioned as certainly of this description. The three

cases, however, which I have related, and I could quote several others, are, I think, conclusive examples of the kind of defect referred to. In all, symptoms indicating mitral insufficiency—a small, irregular pulse, a murmur heard most loudly or only at the apex, and great pulmonary and systemic congestion, had existed during life. In all, also, there was no sufficient amount of disease of the valves or dilatation of the apertures, to explain the incompetency. The only explanation, therefore, which can be given of the symptoms during life and the conditions found after death, is to suppose that from the enlargement of the left ventricle which existed in all the cases, the mitral valves had not been properly adjusted during the systole.

The condition now described is, I believe, by no means of unfrequent occurrence; indeed, I am disposed to think that, when the left ventricle becomes much increased in size, the mitral valves are necessarily rendered more or less insufficient. The defect, therefore, must occur in most cases in which there is any source of obstruction in the aorta or at the aortic valves, and in cases of dilatation depending on any other cause.

The men who work in the deep copper and tin mines of Cornwall are very subject to affections of the heart, generally assuming the form of mitral incompetency. The defect is not usually the sequence of rheumatism nor can it often be traced to any shock or injury, but generally occurs in connexion with the bronchitic or asthmatic affections so common in miners, and known in the district under the names of "*Miners' Asthma*," or "*Miners' Consumption*." I think that most probably the incompetency of the valves is dependent on dilatation of the left ventricle in the way now

mentioned. The only means usually provided in Cornwall for access to and egress from the mines, is by ladders placed in the vertical shafts, sometimes perpendicularly, or only very slightly inclined. When underground, the men are employed in "*beating the borer*," striking with a heavy hammer upon a steel-pointed instrument to bore the holes in the rock to be used for blasting. The air which they breathe in the close ends—places far from any air-vent—is often very impure, being deficient in oxygen and surcharged with carbonic acid, and containing also the various products of the combustion of gunpowder; it is further rendered injurious by the exhalations from the skin and lungs of the men, and by the candles which they burn. The men remain in the mines for eight hours at a time, and sometimes the mines are worked in relays for the whole twenty-four hours, so that there is no time for the atmosphere to be thoroughly changed. After their time of work is expired, the miners return to the surface by the ladders, there being but few mines in which any mechanical means are provided for bringing them up. In this way an hour or more is spent by the men in climbing, and when they reach the surface they are usually much out of breath, and their hearts generally beat violently. The work altogether greatly exhausts their power. At or before the age of forty, they begin to suffer from difficulty of breathing and are liable to palpitation of the heart, and in five or ten years from that time they are, with very few exceptions, compelled to give up working underground.* They then usually labour under

* Of 48 men permanently disabled, the mean period of failure of health was in Cornwall 43 years, and the extremes 21 and 66 years:

symptoms of chronic bronchitis and emphysema, and frequently present also signs of dilatation of the heart and of incompetency of the mitral valve. The pulmonary affections are probably mainly due to the impure air which the men breathe while underground, and to the occurrence of inflammatory affections resulting from exposure to the weather on reaching the surface, when exhausted by labour in hot and close places and wearing the damp clothing in which they work. The cardiac defect I conceive chiefly to arise from the distension and overaction of the heart in the prolonged exertion of climbing. The effect of this must be to interfere with respiration and so prevent the free transmission of blood through the lungs; the right side of the heart will become engorged, the venous system generally congested, and the flow of blood through the arteries being also obstructed, the left ventricle will be distended and stimulated to overaction. The cavities being thus habitually overloaded, the muscular walls must have their contractile power impaired and become permanently dilated; and the dilatation of the left ventricle will prevent the perfect adjustment of the folds of the mitral valve. That this is the correct explanation of the cardiac affections of the Cornish miners I am unable to affirm with certainty, for, though I have carefully investigated the state of a large number of disabled miners during life, I have only once had the opportunity of examining the state of the lungs and heart after death. There can, however, be no doubt that the heart is very frequently dilated and the mitral valve in-

the mean period of labour was, on the average, 28·5 years, and the extremes 5 and 53 years.

competent in a large proportion of the diseased miners in Cornwall, while the same conditions are rare in the workmen in the North of England. Indeed, while the Northumberland and Durham lead miners breathe air which is quite as impure as that of the Cornish mines—perhaps, indeed, in some mines worse—and, in consequence, suffer as severely from the asthmatic affections, they do not appear to be more subject to cardiac disease than men following equally laborious occupations who work in the open air.* The only difference in the circumstances of the two sets of men which seems adequate to explain the difference in their sanitary state, is that in the North there is very little ladder-climbing. The mines are generally entered by horizontal shafts running from the sides of the hills, often for very long distances; and along them the men ride in trucks drawn by horses. Vertical shafts are required to descend into some mines and to pass from level to level in others; but the depths are not generally great, and where much difference of level exists the men are often let down and drawn up by machinery; so that, altogether, they have not to climb to any injurious extent. The present race of miners in Cornwall probably suffer from their occupation at an earlier age and more severely, from

* In Cornwall, of 83 ailing men examined, 9 suffered from some form of heart disease, or 10·8 per cent., independently of the cases of cardiac affection complicating asthma. In the North of England, of 25 sick men, 1 only, or 4 per cent., had cardiac disease, and he had not worked underground for 20 years. The age at which the health failed in men permanently disabled in the North was 49·18 years, and the extremes 60 and 56, and 34 and 44 years, and they became completely disabled, on the average, at 55·07 years, and at the extremes of 63, 47½, and 46 years.

having commenced to work underground when very young. Some of the men state that they begin to work as miners when seven, eight, nine, or ten years of age, and many at eleven or twelve; and a large number of young people are found at work in all the mines.* It is evident that the causes which have been mentioned must act with peculiar severity on persons at such immature ages; and though the effects may not be at once apparent, yet the seeds of premature decay and early death must be implanted in the constitutions of the miners from the very commencement of their career.

It has been contended that the high rate of mortality which prevails among the mining population is due to infirmity of constitution inherited from their parents. Of this, however, there is no proof; on the contrary, the children of the Cornish miners and the females and young persons who do not work in the mines, are remarkably healthy-looking, and unusually free from strumous affections. There is every reason to believe that by the introduction of mechanical means for entering and leaving the deep mines; and by improvements in the ventilation, so as to convey fresh air to the underground workings and lessen the heat and dust, the health of the men would be greatly improved. Probably, however, nothing would do more to reduce the present high rate of mortality than enforcing the rule that boys should not be allowed to work underground till they have attained sufficient age and vigour to be able to resist

* Of 464 men examined in Cornwall, 225, or 48·4 per cent., had begun to work underground before they were 14 years of age; and of the same number, 117, or 25·2 per cent., who were actually at work, were only 20 years of age and under.

the injurious influences to which they must always be more or less exposed. In the London Lead Company's Works in the North of England, the age at which the boys are allowed to go underground has of late years been fixed at eighteen, though they work in the mines for three or four months during winter after the age of fourteen. This plan, I was assured by the medical men attached to the Company at Nent Head, and Middleton in Teesdale, Dr. Carson and Dr. Ewart—had been attended with considerable diminution in the prevalence of disease among the men. The plan of introducing the boys gradually to the underground work is also probably conducive to health, and might be well enforced in any legislative enactments.

The remarks now made complete what I have to say in reference to the causes of valvular disease. The effects of inflammatory affections have already been fully illustrated by others who have occupied this chair before me. It remains therefore, only briefly to remark upon the relative frequency with which disease originates in the different causes specified. Before, however, stating these results, I may remark that the precise cause which has originated the disease is not always by any means easy to be determined.

1. There are cases in which the patients have been delicate throughout their lives, and have specially displayed evidences of defect in the circulating organs; while they have never had rheumatism or any other serious illness, and have never sustained any accident, and in which, after death, the valves display one or other of the forms of defect which have been described.

2. There are other cases in which, after the patients have

sustained a severe injury or strain, when previously in good health, symptoms of heart disease manifest themselves and never afterwards wholly subside, and in which, on examination, the valves are found obviously to have been in some way torn.

3. There are yet other cases in which the patients, without having previously been in impaired health or subject to any symptoms indicating cardiac delicacy, have decided attacks of rheumatism or some other form of acute or chronic disease, in which there is proof that the heart was probably or certainly implicated; and after death, the valves are found to present some of those conditions well known to ensue upon endocarditis.

In cases like this, we can have no hesitation in assigning the valvular disease respectively to malformation, injury, or rheumatism, &c.; but

4. There are other cases of which the causation is very obscure. The valves may have been the seat of some congenital defect, which, though trivial, may have predisposed to subsequent disease; the patient may have sustained an injury, scarcely noticed at the time and nearly or entirely forgotten, yet some portion of the valvular apparatus may have been strained or torn, so as to interfere with their efficient action and lead subsequently to more serious defect; or during a trifling rheumatic attack such as few persons pass through life without suffering, or in the course of some acute inflammatory or febrile affection, the heart may have been slightly affected, and the disease thus first set up may ultimately occasion important changes of structure. Or,

5. And lastly, the patient may have had an attack of rheumatism or some other acute or chronic disease, in which the heart may have been involved; and yet such attack may

not have been the original cause of the valvular disease, but may only have called into active operation some defect which had previously existed in a latent state.

Questions like these frequently arise in considering the probable causation of valvular affections, and make it extremely difficult to decide to what the original development of the disease is to be assigned.

In the accompanying Table, I have given a statement of the particulars of sixty-three cases of valvular disease, which have been under my care during life and in which I have examined the hearts after death. In estimating the causes, the cases probably originating in malformation, injury, and rheumatism, are placed separately ; while those which arise in other ways are classed together, as those caused by gradual over-straining of the valves from hard work, intemperance, cold, diseases of the kidneys, and other chronic or acute diseases.

From this analysis, it appears that—

1. The chief causes of aortic valvular disease, malformation and rheumatism, and all the other causes combined, operate to nearly an equal extent ; the cases in which the valves sustain injuries from violent muscular exertion being too few very materially to affect the result, and probably occurring in variable proportion, according to the locality and rank of life in which observations are collected.

Thus it will be seen, that of twenty-six cases of aortic valvular disease—

9 or 34·6	per cent.	are referred to malformation,
2 or 7·4	„	„ to injury,
6 or 23·07	„	„ to rheumatism, and
9 or 34·6	„	to various other causes combined.

2. Aortic valvular disease, though generally arising in middle and advanced age, displays considerable range in the period of life over which its prevalence is extended; nor is there any great distinction between the ages at which the disease occurs when arising from the different causes, though the cases which are due to malformation occur, in some instances, at an earlier period, and those originating in rheumatism and other causes usually appear later in life.

The mean age of the whole of the patients who died from aortic valvular disease was 43·4, and the range of age from 18 to 76.

The mean age of the cases referred to malformation was 42·3, and the range of age from 18 to 76.

The mean age of the cases originating in rheumatism was 51, and the range of age from 32 to 58.

The mean age of the cases originating in other ways was 42, and the range of age from 21 to 64.

If the whole of the cases originating otherwise than in malformation, exclusive of the results of accident, be calculated, the mean age was 47, and the range of age 21 to 64.

These facts show the influence of over-exertion as an exciting cause of aortic valvular disease, whatever may be the circumstances which predispose to the affection.

3. Mitral valvular disease when existing without any serious affection of other valves, and mitral and aortic valvular disease combined, originate, in by far the largest proportion of cases, in rheumatism.

Thus, of 17 cases of uncombined mitral disease—

11 or 66·7 per cent. were traced to rheumatism, and

6 or 25·2 „ to other causes;

and of 16 cases of combined aortic and mitral valvular disease,

TABLE OF CASES OF VALVULAR DISEASE AND DEFECT.

Total Cases, 63.—Males, 41, ratio per cent. 65·07. Females, 22, ratio per cent. 34·9.

	Cases.	Ratio per cent.	Males.	Ratio per cent.	Females.	Ratio per cent.	Mean Age.	Range of Age.
Aortic Valvular Disease.....	26	41·2	22	84·6	4	15·3	43·4	18 to 76
Originating in Malformation...	9	34·6	8	...	1	...	42·3	18 to 76
Injury.....	2	7·4	2	...	0	...	34·5	33 & 36
Rheumatism.....	6	23·07	6	...	0	...	51·	32 to 58
other Causes.....	9	34·6	6	...	3	...	42·5	21 to 64
Mitral Valvular Disease.....	17	26·9	9	52·9	8	47·05	29·3	9 to 68
Rheumatism.....	11	64·7	5	...	6	...	18·6	9 to 39
other Causes.....	6	25·2	4	...	2	...	51·8	31 to 68
Mitral and Aortic Valvular Disease...	16	25·3	9	56·2	7	43·7	24·8	11 to 46
Malformation.....	2	12·5	2	...	0	...	31·	25 & 37
Rheumatism ...	10	62·5	4	...	6	...	17·6	11 to 27
other Causes.....	4	25·0	3	...	1	...	42·5	32 to 46
Malformation { Mitral & Tricuspid Valvular Dis. 1 }	3	4·7	0	...	3	...	29·0	18 to 37
{ Aortic, Mitral, and Tricuspid ... 2 }	1	1·5	1	...	0	...	32·	
{ Pulmonic Valvular Disease								

2 or 12·5 per cent. were connected with malformation,
10 or 62·5 „ referred to rheumatism, and
4 or 25 „ to other causes.

Of the whole 33 cases, 21 may be regarded as originating in rheumatism, or 63·6 per cent.

4. Both the latter forms of valvular disease occur most commonly in persons in early life or early manhood or womanhood. There is, however, a marked distinction in this respect between the cases which originate in rheumatism, and those occurring in other ways; the rheumatic affections being especially frequent in young persons, while those originating in ordinary causes are common in persons at more advanced periods of life.

Thus, the mean age of the whole of the patients with mitral disease was 29·3, and the range of age 9 to 68.

The mean age of the patients in whom the disease originated in rheumatism was 18·6, and the range of age 9 to 39.

The mean age of those originating in other causes was 51·8, and the range of age 31 to 68.

Of the cases of combined aortic and mitral valvular disease, the mean age was 24·8, and the range of age 11 to 46.

Of the cases originating in rheumatism, the mean age was 17·6, and the range of age 11 to 27.

Of the cases otherwise originating, the mean age was 42·5, and the range of age 32 to 46.

Thus showing, that the comparative early age of the persons who died of some form of mitral disease, was due to the large proportion of the cases originating in rheumatism, and the early age at which the disease under such circumstances arises.

5. The cases of combined mitral and tricuspid, of aortic,

mitral and tricuspid, and of pulmonic disease, are all referred to malformation, and all occurred in persons in early manhood and womanhood.

There are other circumstances not directly referring to the subject of these Lectures, which are illustrated by the Table and may be briefly noticed.

6. It will be seen that of the whole of the cases of valvular disease, those in which the aortic valves were affected are much the most numerous. The cases of uncombined mitral disease and combined mitral and aortic disease, were about equally frequent, and the affections of the right valves alone or in combination with those of the left side, were very rare.

Of the 63 cases—

26 or 41·2	per cent.	were cases of aortic disease.
17 „ 26·9	„ „	mitral disease.
16 „ 25·3	} „ „	{ combined mitral and aortic disease.
3 „ 3·4	} „ „	{ combined tricuspid and mitral and aortic disease.
1 „ 1·5	„ „	pulmonic disease.

These results correspond with those which have been arrived at by other observers, in showing the rarity of serious disease of the right side of the heart, either alone or in combination with disease of the left side, in cases in which the conformation of the heart is otherwise natural. Were, however, the instances of diseases in which there are serious deviations from the natural conformation, to be included in the calculation, it would be seen that val-

vular disease on the right side, is, during foetal life, much more common than is here shown to be the case in after life.

To what is this difference to be referred? The greater prevalence of disease on the left side of the heart in after life, has been ascribed to the larger proportion of the fibrous element in the structure of the valves; to the more stimulating qualities of the arterial blood; and to the more active function and greater exposure to variations of pressure and to injuries, from the connexion with the systemic circulation.

Of these causes, the first cannot, I think, be sufficient to produce any marked influence; but the two last, probably both operate with considerable effect. The increased proportion of fibrine in arterialized blood, is also probably very influential in producing disease of the left side. It is very common to find the lining membrane of the left auricle thickened and opaque in cases where the heart is otherwise healthy, and the condition is almost invariable when the organ is diseased. For the production of this change, I see no adequate cause but the altered qualities of the blood resulting from its aeration.

The greater frequency of disease on the right side in the foetus, has been ascribed to the arterialized blood from the mother entering that side. This is, however, now admitted to be an erroneous idea. The blood which is received by the right auricle is diverted by the eustachian valve through the foramen ovale, and so passes into the left auricle and ventricle and to the ascending aorta. If, therefore, the more stimulating qualities of the maternal blood operated as a cause of disease, it should give rise to affections of the left cavities, not of the right. The only consideration which appears to me adequately to explain

the difference, is, that during foetal life the circulation in the descending aorta and umbilical arteries is in connexion with the pulmonary artery and right ventricle, and thus these parts must be exposed to much greater variations of pressure than the left ventricle and upper portion of the aorta. There can be no doubt, that to the varying pressure in the arterial system much of the prevalence of aortic valvular disease in after life must be assigned; and there seems no reason why the same cause, operating in the foetus on the pulmonic valves, should not be attended with a similar result.

7. Men are shown, by the Table, to be much more subject to valvular disease than women; but, though the difference to the disadvantage of men obtains in all forms of valvular affection, it operates to a much greater extent in cases of aortic valvular disease, than in any of the other forms.

Thus, of the whole 63 cases, the subjects were—

41 males, or 65·07 per cent.

22 females „ 34·09 „

Of twenty-six cases of aortic valvular disease—

22 „ 84·6 per cent. occurred in males,
4 „ 15·3 „ „ females.

Of seventeen cases of mitral valvular disease—

9 „ 52·9 per cent. occurred in males,
8 „ 47·05 „ „ females.

Of sixteen cases of combined aortic and mitral disease—

9 „ 56·2 per cent. occurred in males,
7 „ 43·7 „ „ females.

The three cases of tricuspid disease combined with affection of the left valves, all occurred in females, and the

patient who laboured under pulmonic disease was a male.

It is evident, therefore, that the greater prevalence of valvular disease in males than in females, is chiefly due to the greater frequency in the former of aortic valvular affections. This is doubtless the result of the liability of the aortic valves in men to injury from accident or over-exertion, and to the more common occurrence of various acute febrile affections, originating in cold, intemperance, &c., in men than in women.

LECTURE III.

IN the last lecture I concluded my remarks upon the causes of cardiac disease, and I now propose to speak of some of the effects of disease of the heart; confining my attention to the changes which are produced in the state of the organ itself by the various diseases of which it may be the subject, or in which it may be indirectly implicated. In pointing out these changes it is evident that some standard must be adopted to indicate the healthy condition of the heart, and I shall therefore precede the remarks which I have to make as to the effects of disease, by a notice of the weight and size of the healthy organ.

Corvisart, while feeling the desirableness of some estimate of the size of the heart which should furnish the means of comparison between the healthy and diseased organ, was unable to suggest any satisfactory standard; and Laennec's comparison of the size of the heart to the closed fist of the subject is too indefinite to convey an accurate impression. Lobstein was, apparently, the first writer who suggested that the relative weight of the organ would furnish a more accurate standard, and his suggestion was more fully acted upon by Bouillaud. The last writer, in the first edition of his work, published in 1835, gave observations of the weight of the heart regarded as healthy, in persons at different ages

and in both sexes, but they were too few to form the basis of satisfactory calculations. M. Bizot conceived that the dimensions of the heart would furnish a better standard of comparison, and in the *Memoirs of the Société Médicale d'Observation*, published in 1837, gave a series of measurements of the organ, in both sexes and at different ages. These may still be regarded, for accuracy and fullness, as the most valuable which have appeared. In 1838, Dr. Clendinning published numerous observations of the weight of the heart in a paper in the *Medico-Chirurgical Transactions*; the conclusions from which were, I believe, first mentioned in lectures delivered in this theatre. Shortly after this, or in 1849, Dr. Ranking contributed to the "*Medical Gazette*" a series of measurements of the heart, both healthy and diseased; and in 1843, the late Professor Reid appended to his paper "on the weights of the different organs of the human body," tables of the weight and dimensions of the heart. More recently, or in 1854, I published a considerable number of observations of the weight and size of the organ under different circumstances of health and disease, together with various tables compiled from them. Since this time, the weight of the heart and some of its dimensions, have very generally been given in the reports of cases of disease which have appeared in the different medical transactions and journals.

M. Bouillaud estimated the weight of the adult heart, as ranging in the two sexes, from 8 oz. 10 drms. to 9 oz. 11 drms. imperial. Dr. Clendinning concluded that the mean weight of the healthy organ was in males $8\frac{3}{4}$ oz. and in females $7\frac{3}{4}$ oz. Dr. Reid found the average weight to be 11 oz. 1 dr. in males, and 9 oz. in females. It is, however, probable that

among the hearts which he weighed were some which were not strictly healthy, for his estimates exceed in some degree those of any other observer. It is also, I think, evident that the weight of the heart must vary considerably according to the mode in which death takes place; the organ being heavier when the patient dies after only a short attack of illness, and lighter when death has occurred from lingering and emaciating diseases. Indeed, Dr. Reid found that in twelve adult men who were killed, the weight of the heart attained an average of 12 oz. To form, therefore, a satisfactory estimate, the weight of the organ in acute and chronic diseases should be calculated separately. The size of the heart must also be similarly affected, and especially the dimensions must vary considerably with the degree of distension of the cavities at the time of death. It appears, therefore, that to furnish the required standard of comparison, the weight and dimensions of the organ, the character of the diseases producing death, and the duration of illness, must all be considered.

In the Tables appended to the observations published in 1854, I endeavoured as far as possible to carry out these views. Before stating the results at which I arrived, the mode in which the different observations were made must, however, be explained.

The heart was weighed after the cavities had been laid open, and the organ washed to free it from blood and coagulum. The girth was ascertained, generally, immediately it was removed from the body; the dimensions being taken by a piece of string or tape from the anterior branch of the coronary artery in front to the large vein behind, and

passed over to the broadest part of the organ. The cavities were laid open by incisions, made about half an inch on each side of the septum; that into the right ventricle following the curve of the septum, that into the left passing direct from the base to the apex. The length of the right ventricle was measured by string passing along the convexity of the septum from the base to the apex; that of the left ventricle was taken in a direct line, from the base or upper margin of the muscular septum, to the apex. The thickness of the walls was ascertained on each side, at about half an inch from the base, at the mid-point, and at about a quarter of an inch above the apex. The septum was cut across mid-way between the base and apex, and the width measured at the mid-point of the section so produced. The dimensions of the orifices were ascertained by balls, having a circumference of from one French inch, or twelve lines, to five French inches; and numbered from one to twenty, so that each number exceeded the preceding one by three lines. I adopted the line as the standard of measurement, from its having been employed by Bizot; but in the Tables I have stated the results obtained in parts of English inches and in millimètres, on the estimate that the line equals $\cdot 0888$ of an English inch and $2\cdot 25$ millimètres.

In the first Table it will be observed that I have given an estimate of the weight of the healthy heart in avoirdupois weight, in adult males and females, and in acute and chronic diseases; in the second, the dimensions of the healthy heart, in the two sexes, are stated in lines, millimètres, and parts of inches; and the third Table contains the weight of the heart in males and females, at different ages.

From the first Table, it will be seen that in adult males,

TABLE I.

Average Weight of the Healthy Heart, in Males and Females, and in Acute and Chronic Diseases, from 20 to 55 years of age.

Males—

Mean Weight	9 oz. 8 dr.
Ordinary Range in Acute Cases.....	9 to 11 oz.
" " Chronic ,,	8 to 10 oz.

Females—

Mean Weight	8 oz. 13 dr.
Ordinary Range in Acute Cases.....	8 to 10 oz.
" " Chronic ,,	7 to 9 oz.

TABLE III.

Weight of the Healthy Heart, at different Ages, in Males and Females.

				Males.		Females.	
				oz.	dr.	oz.	dr.
Ages, 10 to 14, inclusive, Mean Weight ...				6	1·5	5	0
" 15 to 20	"	"		8	2·66	8	1·66
From 20 to 30	"	"		9	0·14	8	10·42
" 30 to 40	"	"		9	7·95	8	13·94
" 40 to 50	"	"		9	11·11	9	3
" 50 to 60	"	"		9	12	9	7·33
" 60 to 70	"	"		10	13·33	7	0

Mean Weight between 20 and 55 years of age—

in 76 Males, 9 oz. 8·74 dr.

49 Females, 8 oz. 13·16 dr.

Difference..... 11·58 dr.

Dimensions of the Healthy Heart in French Lines, Millimètres, and English Inches, in Males and Females.

	MALES.			FEMALES.		
	Lines.	Milli- mètres.	Inches.	Lines.	Milli- mètres.	Inches.
Circumference of Heart	103·7	233·32	9·209	104·	234	9·236
Girth of Right Ventricle	55·4	123·85	4·919	58·4	131·4	5·184
Left	48·3	108·67	4·289	45·6	102·6	4·049
Length of Cavity of Right Ventricle	43·3	96·42	3·821	44·3	99·67	3·925
Left	37·6	84·6	3·333	37·1	83·47	3·197
Thickness of Walls of Right Ventricle; Base.....	1·85	4·16	·164	1·85	4·16	·164
" " " Midpoint	1·98	4·35	·176	2·0	4·5	·177
" " " Apex	1·42	3·19	·125	1·3	2·92	·118
" " " Left Ventricle; Base.....	5·15	11·58	·452	4·9	11·02	·432
" " " Midpoint	6	13·5	·532	5·6	12·6	·497
" " " Apex.....	2·4	5·4	·214	2·5	5·62	·222
" " " Septum	5·73	12·89	·51	4·7	10·57	·421
Circumference of Right Auriculo-Ventricular Aperture...	53·4	120·15	4·74	51·4	115·65	4·562
Left	45·2	101·7	4	45	101·25	3·996
Pulmonic	40	90·	3·552	39·3	88·42	3·493
Aortic	35·6	80·1	3·146	34	76·5	3·019

who have died from acute diseases or from the effects of accidents, the ordinary weight of the heart is from 9 to 11 oz. avoirdupois; and in those who have died from chronic diseases, from 8 to 10 oz. In females, the ordinary weight of the heart in acute cases may be estimated at from 8 to 10 oz., and in chronic diseases at from 7 to 9 oz. Occasionally, however, in persons of small and delicate frame, who have died from exhausting diseases, such as cancer of the stomach or chronic affections of the liver, the heart will be found to weigh only 5 or 6 oz.; and in large and powerful persons of the male sex, who have been suddenly killed or have died after short illnesses, the organ may weigh 12 oz., or perhaps even more, without exceeding the limit of health.

From the second Table, it will be seen that the girth of the right ventricle, measured externally, exceeds that of the left, in males by about one-sixth, and in females by one-fifth. The length of the cavity of the right ventricle is greater than that of the left; in males by one-seventh, and in females by one-sixth. In both sexes, the thickness of the walls of the right ventricle is about one-third that of those of the left. The thickness of the septum is intermediate between that of the external walls of the right and left ventricles. In males, the pulmonic orifice is about one-eighth more in circumference than the aortic. The left auriculo-ventricular aperture is one-fourth more than that of the aorta, and the right auriculo-ventricular aperture one-half larger. In females, the differences between the aortic and other orifices are somewhat greater.

It will be further observed, that, according to the third Table, the heart increases in weight with the progress of life; for though the weight in advanced age, in females, is less than at the previous periods, that calculation is based

on too limited a series of observations. I much question, however, whether the result thus indicated can be considered as applicable to the heart in its strictly healthy state. It is well known that in advanced age there is a decided diminution in the weight of the brain, and there seems no reason why a similar decrease of weight should not occur in the heart. That organ, however, is seldom found in elderly persons to be free from some form of disease, which, by occasioning obstruction, would give rise to over-action, and so cause hypertrophy. And even if the heart be not itself at all diseased, there are few old persons who do not display some affection of the lungs or other part of the system, which might more or less interfere with the functions of the heart, and so lead to its enlargement.

In the fourth Table, I have given, for purposes of comparison, the dimensions of the healthy heart, both as calculated by Bizot, and deduced from my own observations. It will be observed that generally there is no marked difference between the two estimates; and the same remark is applicable to the measurements given by Dr. Ranking and Dr. Reid, and to the weights of the heart, as deduced from the observations of Dr. Clendinning and Dr. Reid.

It was supposed by Dr. Clendinning, that the heart in cases of phthisis, contrary to what would, *à priori*, have been expected, acquires an increase of weight, while the rest of the body becomes emaciated. This idea, I cannot but think, arises from a misapprehension of the facts which he collected. The effect of tubercular disease of the lungs upon the nutrition of the heart appears to vary with the form of the disease. In cases of uncomplicated constitutional phthisis—the progress of which is generally rapid, and which is usually attended with great emaciation—the heart

TABLE IV.

Dimensions of the Healthy Heart, in Adult Males and Females, as given by Bizot, and deduced from my own observations.

	BIZOT.				OWN OBSERVATIONS.			
	Males.		Females.		Males.		Females.	
	Lines.	E. Inc.	Lines.	E. Inc.	Lines.	Inches.	Lines.	Inches.
Length of the Cavity of the Right Ventricle	37.2	3.3	34	3.01	43.3	3.821	44.3	3.925
" " Left	34.39	3.05	31.03	2.75	37.6	3.333	37.1	3.197
Thickness of Walls of Right Ventricle, Base	1.9	.168	1.6	.142	1.85	.164	1.85	.164
" " Midpoint	1.4	.124	1.29	.114	1.98	.176	2.0	.177
" " Apex	1.03	.091	.93	.082	1.42	.125	1.3	.118
" Left Ventricle, Base.....	4.5	.399	4.3	.381	5.15	.452	4.9	.432
" " Midpoint	1.15	.457	4.8	.426	6	.532	5.6	.497
" " Apex.....	3.7	.328	3.4	.301	2.4	.214	2.5	.222
" " ".....	4.9	.435	4.4	.39	5.73	.51	4.7	.421
Septum	54.19	6.812	48.25	4.184	53.4	4.74	51.4	4.562
Circumference of Right Auriculo-Ventricular Aperture...	45.5	4.04	41.33	3.67	45.2	4	45	3.996
" Left	32.34	2.871	30.1	2.671	40	3.552	39.3	3.493
" Pulmonic	31.24	2.754	28.8	2.557	35.6	3.146	34	3.019
" Aortic								

TABLE V.

*Range of Weight of the Heart in different Forms of Disease
and when Diseased.*

		Mean,		Extremes			
		oz.	drm.	from	oz. drm.	to	oz. drm.
Phthisis	Males	9	3.4	from 6	4½	to 11	0
	Females	8	6.06	„ 5	9	to 11	0
Chronic Bronchitis	Males	14	8.0	„ 11	8	to 21	0
	Females	12	2.0	„ 9	0	to 12	8
Morbus Renum	Males	9	12.0	„ 7	4	to 14	8
	Females	10	5.4	„ 7	4	to 15	8
		Range					
Simple Hypertrophy	Males	from 12	0	to 40	12		
Aortic Disease	Males	„ 10	0	to 24	0		
	Females	„ 8	8	to 20	0		
Aortic Valvular Obstruction.....	Males	„ 14	0	to 21	0		
	Females	„ 13	0	to 18	8		
Aortic Valvular Regurgitation	Males	„ 14	0	to 34	0		
	Females	„ 16	0	to 23	0		
Mitral Valvular Disease, Obstruction							
or Regurgitation, or both	Males	„ 14	0	to 17	0		
	Females	„ 13	0	to 18	8		
Combined Aortic and Mitral Valvu-							
lar Disease	Males	„ 14	8	to 21	8		
	Females	„ 7	8	to 23	0		

will, I believe, always be found to weigh considerably below the healthy average ; and the organ on examination often displays the appearance of atrophy. In cases of chronic phthisis, on the other hand, and especially where one or both lungs are considerably contracted, or where there have been marked bronchitic symptoms, so that the blood has been for a long period transmitted with difficulty through the lungs, the heart is generally found to be enlarged, or at least not to have undergone any material diminution in size ;

TABLE VI.

Extreme Dimensions of the Heart with the different forms of Disease in which the Measurements occurred.

	Lines.	Millimètres.	English Inches.	
Circumference—Males.....	182	409.5	16.16	In Simple Hypertrophy.
" Females.....	127	285.75	11.27	In Mitral Disease.
Thickness of Walls of Right Ventricle—Males.....	5.75	12.93	.51	In Mitral Disease.
" " Females...	7	15.75	.62	In Congenital Obstruction at Pulmonic Orifice.
" " Left Males.....	14	31.5	1.24	In Aortic Valvular Disease.
" " " Females...	11	24.75	.97	In combined Aortic and Mitral Valvular Disease.
Circumference of Right Auriculo-Ventricular Aperture—	63	141.76	5.59	In Simple Hypertrophy.
" " " Males.....	60	135	5.32	In Aortic Valvular Obstruction.
" " Left Females...	60	135	5.32	In Simple Hypertrophy.
" " " Males.....	45	101.25	3.99	In Aortic Valvular Obstruction.
" " Pulmonic Females...	54	121.5	4.79	In Simple Hypertrophy.
" " " Males.....	39	87.78	3.46	In Mitral Valvular Disease and Chronic Bronchitis with Deformed Spine.
" " Aortic Males.....	45	101.25	3.99	In Aortic Valvular Disease.
" " " Females...	35	78.75	3.1	In Aortic Valvular Disease and combined Mitral and Aortic Valvular Disease.

its weight equalling or exceeding the healthy standard. Two specimens, which afforded good examples of these different conditions, not long ago occurred simultaneously in the post-mortem theatre of the Victoria Park Hospital. In one of these, removed from a man twenty-six years of age, who had died from uncomplicated phthisis of ordinary duration, the heart weighed only $7\frac{1}{4}$ oz. avoirdupois, and was evidently much reduced in size; the cavities being small and the walls somewhat thicker than usual. In the other, from a man, forty-six years of age, who had died of chronic phthisis, complicated by strumous disease of the kidney and bladder, the ventricles were both enlarged and the walls hypertrophied, and the organ weighed 9 oz. 14 drms. The rule, indeed, as before stated, appears to be, that in cases of consumption the weight of the heart ordinarily diminishes with the progressive emaciation, though to a less extent than other parts of the system. When, however, there is any impediment to the transmission of the blood from the heart, the emaciation may be entirely prevented; and in cases of great obstruction in the heart or arteries the organ may very greatly exceed the natural size. I have examined hearts, under these circumstances, removed from persons who were phthisical, which weighed 15 oz., 16 oz., and 24 oz. in males, and 13 oz. and 15 oz. in females.

The most remarkable cases of increase in the size and weight of the heart are those in which there is general hypertrophy; without the existence of any material valvular disease or any obvious source of obstruction in the aorta, to explain the condition. I have met with cases of this description, in which the organ ranged in weight from the healthy standard to 40 oz. 12 drms.; the last being, indeed, the weight of the

heaviest heart which has fallen under my own notice. In this case, the patient was a man, sixty-five years of age, who died suddenly, and with whose previous history I am not acquainted. In another instance, a man of thirty-five years of age, whom I saw during life with Mr. Hutchinson, the heart weighed 26 oz.; and Dr. Bristowe, some time ago, exhibited at the Pathological Society a heart which weighed 27 oz. It was removed from a patient at St. Thomas's Hospital, and there was no valvular disease, nor, indeed, anything to explain the great increase of weight. The subject of the disease was a ship smith, forty-one years of age. I have met with many cases in which the heart was simply hypertrophied to a less marked degree. It is difficult to explain the great enlargement which occurred in the cases mentioned. There may have been some disease in the smaller arteries which may have escaped observation, or the hypertrophy may have been due to obstruction in the capillaries; but it is probable that, in other cases, it may have originated simply in over-action from hard work, or possibly, in the first place, from purely emotional causes. Dr. Bright some years ago pointed out that simple hypertrophy of the heart was not uncommon in cases of disease of the kidneys, and in some of the instances referred to, those organs were diseased. Enlargement, unconnected with valvular disease is, however, rarely seen, except in men; and in no instance have I found the heart much hypertrophied in females, without there being some obvious source of obstruction to which the change was referrible.

The profession have now generally adopted the views of Cruveilhier and Dr. Budd, as to the cases in which the walls of the heart are found of increased thickness and the cavities diminished in size, the so-called "*con-*

centric hypertrophy." The condition is admitted to be due to the powerful contraction, at the time of death, of a large and strong left ventricle. Some years ago, a very characteristic instance of the kind fell under my notice :—A man, thirty-five years of age, was crushed by a heavy frame of timber, when making great efforts to save himself, and died instantly. On examination, the aorta was found to be almost entirely torn across, between the point of origin of the left subclavian artery and the insertion of the ductus arteriosus. Naturally, the vessel is rather narrow in that situation, and the constriction was in this case somewhat greater than usual, and there was a plate of atheroma in the lining membrane. The heart when first examined was of moderate size and its walls firm; and both ventricles were strongly contracted—the left especially so, the walls being so thick that there was scarcely any cavity remaining. After the organ had been in water for some time the walls became relaxed and the cavities dilated; the heart proving to be large and well developed, and weighing between 11 and 12 oz.

While, however, these views are generally entertained in reference to the condition of the heart in after life, it has been thought that in malformations of the organ true concentric hypertrophy does occur. I am, however, convinced that the explanation which holds good in reference to the former class of cases, is equally applicable to these. It will be found in cases of malformation, that when the heart is first examined, though the walls of the right ventricle may be thick and the cavity almost absent, the contraction will disappear on maceration, and the ventricle prove to be of large size for the age of the subject. In museums, specimens of apparent concentric hypertrophy are not unfre

quently to be seen ; but I believe these are to be explained by the organs having been placed in spirit, before the firm contraction of the walls had subsided.

The occurrence of obstruction in the aorta, and especially in the upper portion of that vessel, is generally attended by considerable increase of weight in the heart. In various cases of this description the weight of the heart ranged from near the natural standard to 24 oz. in males, and attained 17 and 18 oz. in females. In the Transactions of the Medical and Chirurgical Society, a case is recorded by Dr. Bennett, in which the heart weighed $22\frac{1}{2}$ oz., in a man fifty-three years of age, who died from rupture of the aorta giving rise to dissecting aneurism and hemiplegia. The increase of size in the heart was apparently due to atheromatous disease of the aortic coats.

In cases of aortic valvular obstruction, still greater increase of weight is often met with. Of this description I have weighed hearts ranging from 14 to 21 oz. in males, and from 13 oz. to 18 oz. 8 drms. in females ; and in cases of aortic valvular incompetency, I have found the heart to weigh from 14 to 34 oz. in males, and from 16 to 23 oz. in females. Dr. Van der Byl, in a paper in the Pathological Transactions, related instances in which the heart weighed 36 oz., in a case of aortic valvular incompetency, in a man of twenty-eight ; 30 oz., in a case of aortic disease with aneurism of the aorta, in a man of thirty-three ; and of 30 oz., also, in a case of aortic and mitral valvular disease, in a man of sixty-two.*

In these forms of disease it is impossible to say how much of the great increase in the weight of the heart, is due to the obstruction and how much to the incompetency of the valves ;

* Path. Trans. ix. p. 175.

for the latter condition is generally only the final stage of the former. In cases of injury of the aortic valves during violent effort, we see the remarkable changes which may occur in the heart, even during short periods of time; where, in organs previously healthy, the valves being rendered incompetent, the left ventricle rapidly becomes hypertrophied and dilated. Thus, in the first of the cases of the kind which I have related, the patient survived the accident only twenty-seven months, yet the heart was found to weigh $17\frac{3}{4}$ oz. In one of Dr. Quain's cases, the patient lived two years, and the heart weighed $22\frac{1}{2}$ oz.; and in the other case which I had the opportunity of examining after death, though the patient had only survived three and a half months, the weight was 23 oz. If the heart was sound at the time of the occurrence of the injury, the process of enlargement must, in this instance, have been most rapid. It may, however, be doubted whether the organ was not more or less hypertrophied before the accident, though the patient stated that he was previously quite well.

In some cases of disease also, the enlargement must have taken place very rapidly. Thus, in the case of the boy of eighteen, who died of aortic valvular disease originating in malformation, the duration of active illness was only three and a half years, yet the heart weighed 28 oz. In a case of aortic valvular incompetency, with probably regurgitation through the left auriculo-ventricular aperture from mal-adjustment of the valves, described by Dr. Bristowe in the *Pathological Transactions*, the heart weighed $46\frac{1}{2}$ oz. avoirdupois, though the subject of the disease was only twenty-two years of age.*

* Dr. Halliday Douglas some years ago, in a series of papers in the "*Edinburgh Journal*," drew attention to the importance of changes in the capacity and thickness of the walls of the ventricles, as immediately

Cases of mitral valvular disease, whether consisting in obstruction and regurgitation from contraction and permanent patency of the aperture, or in free regurgitation from expansion of the orifice or mal-adjustment of the valves, the heart does not ordinarily attain by any means so great an increase of weight as in the forms of disease last named. I find that in males the weight of the organ in cases of this kind ranged from 14 oz. 8 drms. to 17 oz. 8 drms.; and in a case which has more recently occurred in a male of nineteen, in which the mitral valve was greatly contracted and the aortic and tricuspid valves somewhat thickened, the heart weighed $20\frac{1}{2}$ oz.* In females, the range of weight in cases of mitral valvular disease was from 12 to 18 oz. The organ is generally heavier in cases where the defect consists chiefly in regurgitation than where there is also very considerable obstruction.

As might, *à priori*, be expected, the weight of the heart in cases of combined aortic and mitral valvular defect, occupies an intermediate position between that in cases of aortic and of mitral valvular disease; the organ being generally lighter than in the former and heavier than in the latter form of disease. I find the weights of the heart to have ranged in cases of this description, in males from 14 oz. 8 drms. to 21 oz. 8 drms., and in females from 17 oz. to 23 oz.

giving rise to the symptoms in cases of different forms of valvular disease; and there can be no doubt that his views are correct, and that the attention is too apt to be concentrated on the valvular defect, which is of comparatively little importance so long as the ventricles are capable of overcoming the obstruction. The symptoms are, indeed, often referred only to the latter period; the previous state of gradually increasing obstruction being wholly overlooked, and causing little or no inconvenience.

* Path. Trans. viii. p. 127.

When there is obstruction to the pulmonary circulation from chronic bronchitis, with or without deformity of the spine, or contraction at the pulmonic or right auriculo-ventricular apertures, the weight of the heart is not generally very much greater than natural, though sometimes it is found to exceed considerably the healthy mean. In the former class of cases the weight ranged from the average up to 15 or 16 oz. In a case of pulmonic obstruction in a man of twenty, the heart weighed only 12 oz., while in a female of nineteen it weighed $17\frac{1}{2}$ oz.; but in both these instances there were other serious deviations from the natural conformation of the organ. In a case of marked disease of the mitral and tricuspid valves with some thickening and contraction of the aortic, in a female aged thirty-seven, the heart weighed only 9 oz.

The effect which is produced by adhesions of the pericardium upon the functions of the heart and the consequent nutrition of the organ, has been the subject of much discussion. On the one hand, an adherent pericardium has been supposed always to create obstruction and so to give rise to hypertrophy; on the other, it has been considered that in some instances the compression exercised upon the organ might occasion atrophy. The question is one which it is not easy to decide; for there are few cases in which the pericardium is entirely adherent, in which the valves are not also more or less thickened and rigid, and where, consequently, the effect produced by the one condition may not be modified by the other. I find that in cases in which there were extensive adhesions of the pericardium and the valves were not implicated, the heart weighed 16 oz., 17 oz. 4 drms. and 18 oz. in

men. I have, however, weighed other hearts in which the pericardium was adherent by old attachments, and the weight did not materially exceed the healthy standard ; but I have met with no instance in which there was reason to suppose that any actual decrease of weight had occurred. The general rule, there can be no hesitation in stating to be, that the organ becomes hypertrophied in cases of adhesion of the pericardium, provided sufficient time elapse for that process to take place.

M. Bouillaud has collected some cases in which the heart, otherwise healthy, weighed considerably less than the natural weight ; and others in which, in connexion with various states of disease, it considerably exceeded that point. The former are all cases in which the organ was reduced in weight with the progressive emaciation of cancer, consumption, &c. The lightest heart weighed 4 oz. 5 drms. in a female, forty-five years of age, who died of cancer of the pylorus ; the heaviest heart weighed 24 oz. 4 drms., in a case of obstructive and probably also regurgitant disease of the aortic valves, in a female of fifty-three. From a calculation based on these observations, and on the estimate of the weight of the healthy organ as being from 8 oz. 10 drms. to 9 oz. 11 drms., he infers that the heart may attain three times the weight of the average healthy organ, and five times that of the most atrophied organ.

The facts which I have collected show these estimates to be considerably less than the variations of weight which actually obtain. I have found the weight of the heart to be very considerably below the average which I have regarded as that of health, in persons who have died of

different forms of disease attended with great emaciation. Thus in a male of fifty-three years of age, who died of cirrhosis of the liver, the heart weighed only 5 oz.; in one of thirty-nine, who had cancer of the pylorus, it was 6 oz. in weight; and in a third, of thirty-five years of age, who was consumptive, the weight was 6 oz. 12 drms. The average weight of the heart in the adult, it will be recollected, was estimated at 9 oz. 8 drms., and the most hypertrophied heart weighed 40 oz. 12 drms. It results, therefore, that in man the heart may attain a weight which is four times that of the healthy, and eight times that of the atrophied organ.

In females, the variations in the weight of the heart are sufficiently remarkable, though considerably less than in men. The average weight has been shown to be 8 oz. 13 drms.; the lightest hearts weighed 5 oz. 8 drms., 5 oz. 8 drms., and 5 oz. 12 drms. in cases of phthisis, in persons twenty-five, thirty-five, and twenty-one years of age, respectively; the heaviest organ weighed 23 oz. The most enlarged heart was, therefore, three times the weight of the average, and four times that of the most atrophied organ.

The heaviest heart which has occurred in my own observation was, it will be observed, 40 oz. 12 drms. in weight. Dr. Clendinning has included in his tables an organ of exactly the same weight; and Dr. Hope says that he examined at St. George's a heart which weighed $2\frac{1}{2}$ lbs., or, if avoirdupois had been the weight employed, 40 oz. M. Lobstein found a heart to weigh 34 oz.; and I have referred to one mentioned by Dr. Van der Byl, 36 oz. in weight. These weights are, however, exceeded by the heart described by Dr. Bristowe, which weighed $46\frac{1}{2}$ oz. avoirdupois. The diseases of which Dr. Clendinning's, Dr.

Hope's, and M. Lobstein's patients died are not recorded : my own case was one of simple hypertrophy ; Dr. Bristowe's of aortic valvular disease, with probably incompetency of the mitral valve and adherent pericardium ; and in Dr. Van der Byl's case there was aortic valvular incompetency. The ages of the patients in the last cases were sixty-five, twenty-two, and twenty-eight ; Dr. Clendinning's patient was sixty-three years of age ; and were all males.

The dimensions of the heart in different forms of disease bear a general relation to the weights of the organ in similar conditions. It has been seen that in cases of simple hypertrophy, obstruction in the course of the aorta, and obstructive and regurgitant disease of the aortic valves, the organ attains its greatest increase of weight. It is equally in those forms of disease that its dimensions are the most considerably enlarged ; the cavities and orifices, especially those of the left side, being the most expanded, and the walls the most remarkably increased in thickness. There are, however, some differences in the condition of the organ in these several forms of disease. In cases of obstruction on whatever cause dependent, the heart is not generally so large as in cases of incompetency ; and the form of the organ is also somewhat different. In the former class of cases the heart is peculiarly long and pointed at the apex, and the walls attain the greatest width near the base. In the latter the ventricle is usually of larger size, and rounded at the apex, and the thickening is more equably diffused over the walls. In both forms of disease the enlargement, though most marked on the left side, affects the right also very considerably.

The largest girth of the heart in cases of the description named was 182 (16·163 E.I.), 138 (12·254), and 171 (15·184)

French lines respectively. The extreme length of the left ventricle was 51 (4·529 E.I.), 42 (3·729), and 60 (5·328) French lines; the greatest thickness of the walls was 11 (·976), 11 (·976), and 10 (·888) lines; and in a case of dilatation of the aorta with slight valvular disease, 14 (1·243) lines. The extreme length of the right ventricle was 62 (5·5), 48 (4·262), and 72 (6·394) lines; and the greatest width was 3 (·2664), 3 (·2664), and 2·5 (·222) lines. These dimensions being those of the hearts of male subjects, and exceeding in every particular the size in females.

In cases of mitral valvular disease, the dimensions also correspond with the weights of the heart; the size of the organ being considerably less than in the former class of cases, and the shape being very different. The condition of the heart also varies with the form of disease. In cases of great contraction with more or less permanent patency of the left auriculo-ventricular aperture, the stress falls chiefly on the left auricle and the right ventricle and auricle, and their cavities are found expanded and the walls increased in thickness and much firmer than natural; the orifices also being dilated. In cases, on the other hand, in which the defect chiefly consists in incompetency of the mitral valves, whether resulting from disease or maladjustment or due to expansion of the aperture, the left ventricle is found to be considerably dilated and hypertrophied, and thickening and enlargement of the right side are less marked.

The extreme girth of the heart in cases of mitral valvular disease was 127 (11·278 E.I.) lines, the length of the left ventricle 42 lines, and the thickness of its walls 5 (·444) lines. The length of the right ventricle was 51 (4·529) lines, and the width of its walls 3 (·2664) lines—the heart measured being that of a female.

In cases of combined aortic and mitral valvular disease, the enlargement of the heart, like the weight, is intermediate between that in the other two forms.

In cases of obstruction to the circulation through the lungs and disease of the valves of the pulmonary artery, the right ventricle and auricle are greatly hypertrophied and dilated, and ultimately the left-side also becomes involved. In cases of chronic bronchitis, the walls of the right ventricle attained a width of 5 ($\cdot 444$ E.I.) lines and 5 $\cdot 57$ ($\cdot 51$) lines, the cavity also being very large. In two cases of pulmonary valvular obstruction, combined with other defects of congenital origin, in a male and female, the width of the walls of the right ventricle was 7 ($\cdot 62$) lines, the left ventricle being only 6. In one of these cases the length of the right ventricle was 53 ($4\cdot 7$) lines, and that of the left 46 ($4\cdot 08$) lines.

From the striking contrast which, in the last class of cases and in some of those where there is great contraction of the mitral valve, is presented between the conditions of the cavities, walls, and orifices of the two sides of the heart—the right side being very large, and the left small—it has been supposed that in some such instances an absolute reduction of size occurs in the left ventricle and aortic orifice. I believe, however, that this idea is not correct. It is chiefly in cases of disease which has occurred during intra-uterine life or in early childhood, that this contrast is most strikingly seen; and the apparently atrophied condition of the left side is probably due to the partial or complete arrest of growth on that side, while from the obstruction to the passage of the blood through the lungs, the right cavities are greatly enlarged in every direction.

The greatest thickness of the walls of the left auricle which I have noticed is 2 ($\cdot 177$ E.I.) lines in cases of aortic valvular disease, mitral disease, and the two combined. Of the right

auricle, the greatest thickness is $2\frac{1}{2}$ (.222) lines in a case of aortic valvular disease, and 3 (.266) lines in a case of mitral disease.

The septum partakes of the dimensions of the two ventricles: its greatest width was 11 (.976 E.I.) lines in the man who laboured under hypertrophy without valvular disease, and 6 (.532) lines in a case of mitral contraction.

The orifices of the heart also undergo remarkable changes of capacity in different forms of disease.

The aortic orifice was in a male 45 (3.996 E.I.) lines in circumference in the case of simple hypertrophy, and only 24 (2.131) in a case of contraction of the aperture. In females it was 35 (3.1) lines in a case of combined aortic and mitral disease, and only a slit of 10 (.888) lines in a case of contraction probably of congenital origin. The pulmonic aperture measured 54 (4.795) lines in the case of simple hypertrophy, and only 12 (1.06) lines in a case of congenital disease in a man of twenty. In females it measured 39 (3.463) lines in a case of mitral disease, and only 8 (.71) in a person of twenty years of age who presented different congenital defects.

The left auriculo-ventricular aperture had an extreme circumference of 60 (5.328 E.I.) lines in the case of simple hypertrophy, and of only 12 lines (1.06) in a case of combined aortic and mitral disease. In females it measured 45 (3.996) lines in a case of obstruction at the aortic orifice, and only 12 (1.06) and 18 (1.59) lines in cases of mitral contraction. The right auriculo-ventricular aperture had an extreme capacity of 63 (5.594 E.I.) lines in a male, in the case of simple hypertrophy, and of 60 (5.328) in a female, in a case of obstruction of the aortic valves, and of only 16 (.864) lines in a case of combined mitral and tricuspid contraction, and 21 (1.864) lines in a case of combined aortic, mitral and tricuspid disease, both of the patients being females.

The capacity of the apertures varies considerably even during short periods of illness. Thus it will generally be found that in cases of acute bronchitis and very acute phthisis, the pulmonic aperture, which ordinarily exceeds the aortic somewhat in capacity, is disproportionately larger than the aortic, and the right auriculo-ventricular aperture equally out of proportion with the left.

I have some reason to believe that the apertures may not only expand in a short time, but may also have their dimensions reduced without being otherwise diseased. If this be the case, it is possible that in some forms of valvular defect reduction in the size of the orifice may occur, and so lessen the valvular incompetency. In one of my own cases of injury of the aortic valves, the aperture had only a circumference of 30 (2.664) lines, or 1-5th less than natural, while the pulmonic orifice measured 42 lines, or was somewhat larger than natural. There was no reason to suppose that the heart was not quite sound at the time of the occurrence of injury; and I was therefore led to infer that the diminution in the capacity of the aortic orifice had occurred subsequently to the accident, and had proved in some degree compensatory for the valvular defect.

The observations which have been made as to the condition of the heart in different forms of disease, are, I venture to believe, not only interesting in a pathological point of view, but may also possess some practical importance.

In aortic valvular disease, whether obstructive or regurgitant, but especially in the latter, the heart being considerably increased in all its dimensions, and particularly in length, the dullness on percussion is found to be much extended beyond

the proper limits, and especially to commence at a high level and to reach below and further to the left than natural. Sometimes, however, the organ, though greatly enlarged, occupies a very oblique position, with its right margin resting upon the diaphragm. In these circumstances, the dull space may not be much raised, but extends far to the left. In both conditions the apex of the heart is found to beat below and considerably to the left of the ordinary point of pulsation. When this is the case, the ascending portion of the aorta being dragged upon by the heavy organ, sometimes becomes considerably elongated.

In mitral valvular affections, and especially in cases of contraction and insufficiency, the heart, though not so generally enlarged as in the former kind of disease, is greatly increased in width; and hence the dull space, while not rising to a materially higher level than natural, is much more extended laterally, advancing to the right and reaching also to the left of the natural limits. From the rounding of the apex of the ventricle, the point of pulsation can often not be detected, and the pulsation is diffused over a wide space.

The appearance of persons labouring under these several kinds of disease in their characteristic forms, and the symptoms of which they complain, are also generally strikingly different. In a case of incompetency of the aortic valves, the patient has usually a peculiarly pallid anæmic appearance and an anxious expression of countenance. He complains of sense of weakness and exhaustion, and has a tendency to syncope; his breathing is rapid, short, and panting; he does not generally suffer materially from cough or expectoration, nor are there at the earlier periods any marked evidences of pulmonary congestion; and the engorgement of the venous system and of the viscera only occurs when the disease has reached an

advanced stage. In cases of mitral disease, whatever be its form, whether there be great obstruction and only slight insufficiency, or little or no contraction of the orifice and free regurgitation, the patient has a peculiarly turgid, puffy countenance, and the cheeks, lips, and extremities are very livid. He complains of oppression at the chest, with difficulty of breathing, cough and expectoration, generally frothy and often bloody; the lungs present marked signs of congestion; symptoms soon arise indicating that the different viscera—the brain, liver, and kidneys—have become more or less engorged; and serous effusion into the cellular tissue and into the sacs of the pericardium, pleura, and peritoneum, rapidly takes place.

We are all familiar with the peculiar pulse which is so characteristic of aortic valvular incompetency, rising as it does rapidly under the finger and equally rapidly disappearing; and with the visible and contorted beat of the superficial arteries, especially of the temporal, occipital, and radial. The small, feeble and irregular pulse is almost equally distinctive of incompetency of the mitral orifice.

The explanation of these different symptoms is at once evident, when the nature of the several forms of valvular disease and the changes which they respectively induce in the state of the heart, are considered. In cases of aortic valvular regurgitation, the left ventricle being of great capacity, a large column of blood is thrown into the artery during the systole of the ventricle; and from the aperture not being properly closed, a considerable portion immediately returns at the commencement of the diastole. Hence the large and full pulse, followed by the almost instantaneous collapse of the artery. Owing to the regurgitation of the blood from the aorta into the ventricle, the circu-

lation in the smaller arteries and capillaries is imperfectly maintained; hence the pallid face and anxious expression of countenance and the sense of weakness and faintness. From the increased power acquired by the left ventricle during the stage of obstruction which generally precedes the occurrence of incompetency, the heart long resists the diseased process; and hence the occurrence of pulmonary and systematic congestion are often considerably delayed.

In cases of mitral incompetency, a portion only of the blood which is contained in the cavity of the left ventricle is thrown into the aorta; while the other portion which flows into the left auricle, keeps that cavity constantly more or less distended. The pulmonary veins and arteries have the circulation in them retarded, the right ventricle becomes dilated and more or less hypertrophied, the auriculo-ventricular valves no longer close the aperture from maladjustment, and the general venous system and parenchymatous organs soon become engorged. Hence the small feeble irregular pulse, the turgid countenance, the lividity of the surface, the secondary affections of the different viscera, and the early appearance of dropsical effusions.

It has been generally considered that the prospects of longevity are greater in persons who labour under affections of the aortic than of the mitral valves. Yet, though the various secondary affections more readily occur in the latter than in the former class of cases, I believe that the received opinion as to the relative duration of life in the two forms of disease is erroneous. I have met with cases in which patients with marked signs of mitral insufficiency, have survived for many years; and we all know how frequently

such cases come under treatment both in public and private practice, again and again; the local complications being readily relieved, and the patients soon regaining a comparative state of health. On the contrary, in cases of aortic incompetency, we very rarely find that the patients derive any very material benefit from treatment, and such cases as we have the opportunity of watching generally prove fatal in no long time. Indeed, notwithstanding the greater frequency of such cases, I am unable to refer to any instance in which life has been sustained for a considerable period. Probably injuries of the aortic valves present the condition under the most favourable circumstances for the prolongation of life, and yet I have already shown how very limited is generally the period during which such patients survive. It will be remembered that of the nine cases of injury of the aortic valves to which I have referred, life was maintained for the longest period in two of those which I have myself reported. In one of these, the patient died three years after the occurrence of the accident, but as no post-mortem examination took place, the precise nature of the injury is uncertain; in the other, the patient was still living when the last information was obtained, five years after the accident had occurred.

In reference to the prognosis in cases of valvular disease, the mode in which death is liable to occur must also be considered. In aortic valvular disease, death usually results from failure of the power of the left ventricle, and hence may take place suddenly and when least expected; and this, not only in cases of very serious defect, but when there is only slight insufficiency, or when the valves are quite competent. On the other hand, in cases of mitral valvular disease, death is generally due to the pul-

monary engorgement and other secondary affections, or to the progress of the dropsical effusion, and is usually more gradually brought about. It is worthy of observation, that in cases in which the heart is most remarkably enlarged, sudden death is yet of common occurrence. Such was the termination of the case which fell under my notice, where the organ, though not the seat of valvular disease, weighed 40 oz. 12 drms. ; and in that of Dr. Bristowe, in which there was incompetency of the aortic valves, and the weight was 46 oz. 8 drms.

The remarks which I have made as to the duration of life are intended to apply to cases of incompetency of the aortic and mitral valves, not to instances of obstruction at those orifices. In cases of mitral disease, it would often be difficult, if not impossible, to distinguish between simple obstruction and regurgitation ; and hence, no comparison can be instituted between the duration of life in such instances and those of aortic obstruction. In the latter form of disease, however, we know that, provided the obstruction be not great, life may, under favourable circumstances, be prolonged for many years and a large amount of health and vigour be enjoyed ; and it has been shown that even the most aggravated disease of the valves is compatible with freedom from cardiac symptoms for many years. The cases which I have referred to, as reported by Dr. Stokes and Dr. Graves, and still more strikingly one of those which I have myself mentioned,—in which the patient died at seventy-six years of age, and then not of symptoms referable to the heart,—may be referred to in support of this assertion.

The question of the viability of patients with different forms of valvular disease, does not admit of solution by numerical estimates. From the gradual way in which many valvular affections make their advance, it is often

quite impossible to give a statement of their precise duration; and even in cases in which the symptoms can be traced to a definite period, that is often the time at which the heart ceased to be capable of overcoming the long existing obstruction, not the period at which the obstruction first occurred.

I can scarcely conclude these lectures without alluding, though most briefly it must necessarily be, to the principles which should guide us in the treatment of the several forms of disease to the consideration of which they have been devoted.

In cases of aortic valvular disease, the patient suffers chiefly from failure of power in the left ventricle, by which the heart becomes incapable of adequately maintaining the circulation. The various secondary affections only occur when under the influence of increasing disease, prolonged over-exertion and constantly recurring distension, the obstruction has become extreme, the valves have ceased to be competent, and the walls of the left ventricle have had their contractibility considerably impaired. The indications therefore are to avoid the occurrence of further disease, to assist the defective power of the heart, and to uphold the strength of the general system.

In cases of mitral valvular defect, on the contrary, the sources of danger are the occurrence of pulmonary obstruction and the development of the secondary visceral congestions. Special attention must, therefore, be directed to prevent the occurrence of bronchitic and pulmonary inflammation, and to regulate the state of the digestive, secreting, and excreting organs.

For the accomplishment of these purposes, the great object must be to quiet the action of the heart on the one hand, and uphold the strength of the patient on the other.

In all cases, rest is of the greatest importance ; the patient must either be entirely restricted from active exercise, or must be cautioned only to walk leisurely and as much as possible on level ground ; and these directions, of importance in all cases, become most essential in cases of disease dependent on injury of the valves. In these cases, life can only be prolonged by the left ventricle acquiring power to maintain the circulation, notwithstanding the insufficiency of the valves ; and for this to be accomplished time is required. The patient must therefore be kept perfectly at rest ; not only that the left ventricle may very gradually gain the requisite increase of power, but that the ruptured valves may, if possible, acquire a fresh attachment, so as still to be able to perform though imperfectly their functions. The orifice also may during the state of rest contract and lessen the space to be closed, and so diminish the regurgitation. The strength of the patient must also in these, as in all other cases, be kept up by a nourishing diet and stimulants as required.

In acute affections of the heart, I was long afraid of the use of fermented beverages, lest they should aggravate the overaction of the heart ; but more extended experience has taught me, as I dare say it has other members of the College, that in no form of disease are stimulants more useful than in cardiac affections of all kinds. In deciding whether to have recourse to them in any given case, we may safely dismiss all consideration of the special disease, and consider simply the power of the heart and the general condition of the system. If these are defective, stimulants may be given ; cautiously, it is true, and with fair reference to the degree of prostration, but with certainty that instead of causing excitement they will lessen the frequency of the

pulse, and so tend to promote the natural remedial changes. In the exhibition of stimulants the stronger alcoholic beverages, as sherry or brandy, should be preferred to malt liquors or the light wines, which might distend the stomach or cause acidity and generate flatus, and so indirectly embarrass the heart without materially supporting the strength of the patient.

The diet, also, must be cautiously regulated. The patients should live upon plain and easily digestible but nutritious food ; and both the food and beverage should be taken in small quantities at a time and at frequent intervals ; repletion, and exhaustion from too long fasting, being equally injurious. The patients should also particularly avoid undue exposure to cold, and protect the surface by wearing warm clothing, and especially endeavour so to maintain the circulation in the extremities.

The medical treatment should consist in the use of mild alteratives and diuretics—blue pill, rhubarb, the alkalies, &c., followed by tonics, especially the mineral tonics—iron, &c., to guard against visceral congestion, and uphold the strength of the system. The use of alteratives being more especially called for in cases of mitral disease, whether obstructive or regurgitant ; and the employment of tonics being more generally applicable in cases of aortic disease, and especially of regurgitation.

It is well known that digitalis possesses special action upon the heart, lessening the frequency of its pulsations ; and it has hence been supposed that it is particularly applicable as a remedy in cases of cardiac disease. It has, however, I conceive, been employed too generally and too indiscriminately in their treatment. In many cases of disease, and, indeed, usually in cases

of obstruction at the aortic orifice or in the course of the aorta, and always in cases of incompetency, the heart acts violently because it has a serious obstacle to overcome ; and to reduce the power of its contraction would be equivalent to adding to the obstruction. In such cases, therefore, a remedy which like digitalis impairs the power of the heart, cannot but be injurious. It has, I am aware, been contended that digitalis not only lessens the frequency, but increases the power of the heart's pulsations ; that, indeed, it exercises a tonic influence over the muscular structure. I have, however, not seen any decided proof of the correctness of this opinion ; it has several times occurred to me to observe the symptoms of cardiac incompetency greatly aggravated by the use of the remedy, and equally remarkably lessened by its discontinuance. The sedative influence of digitalis appears to be only exercised upon the heart and arteries when it is employed for a short time ; if long continued it loses that power, and produces a depressing effect upon the general system, under which the pulse becomes both feebler and quicker. I have noticed that when patients have taken digitalis, even in small doses, for a long time, the discontinuance of its use and the exhibition of stimulus, has been attended by a great improvement in the general condition, and a proportionate diminution in the frequency of the pulse. I have at present in St. Thomas's a man labouring under aneurism of the common carotid artery, who some time ago was placed under digitalis combined with a nutritious diet ; under this treatment his strength declined and his pulse became feebler and quicker. The digitalis was discontinued and some wine given, and with this change the pulse fell and continued quiet, the local disease

making little progress for many months. In another patient, also at present in the hospital, a boy labouring under mitral valvular disease, the sequence of acute rheumatism, the pulse fell under the use of digitalis, combined with quinine and iron and wine. To test whether this was due to the remedy or to the tonic medicine and diet, I decreased the digitalis, but found that the pulse still fell, the reduction being evidently due to the increasing strength and vigour of the patient.

In cases of mitral valvular disease, I believe, however, that digitalis is eminently useful; not by any influence which it exerts over the heart itself, but from its powerful diuretic action, by which it tends to lessen the amount of the blood, to relieve congestion, and promote the absorption of any fluid which may have been effused, and so indirectly to assist the action of the heart. Dr. Withering, when speaking of the use of digitalis in dropsy, says, that it is not in cases where "the patient is strong, the skin warm, and the pulse firm and hard, and the anasarcaous limbs tense and resisting," that the remedy operates beneficially; on the contrary, "when the pulse is feeble and intermitting, the countenance pale, the lips livid, the skin cool, the belly soft and fluctuating, and the limbs pit freely on pressure," the diuretic action is satisfactorily established, and with the greatest advantage to the patient. Or, in other words, digitalis is effectual in those cases of dropsy which, in a large proportion of instances, we now know to be dependent on or connected with mitral valvular defect. It must, however, be recollected, that in these cases also the action of the remedy requires to be carefully watched and the strength of the patient to be upheld,

so as to guard against too depressing an influence being exercised upon the heart.

The caution which is required in the employment of digitalis in these cases, applies equally to the use of any other depressing remedy. Dr. Stokes, in his admirable work on diseases of the heart and aorta, remarks, "that the practitioner should never forget that local diseases, themselves incurable, may co-exist with an excellent state of the general health, for a period indefinitely long; and the conclusion is but too obvious, that, as the disease cannot be cured, the system at large should not be tampered with." In cases of cardiac disease, the changes which have already occurred it is beyond our power to remove, but we may nevertheless do much to promote the comfort and prolong the life of the patient. By a judicious system of diet regimen and medicine, we may prevent the occurrence of the various secondary affections, or relieve them when they arise; and we may so in many cases enable the patient to enjoy a large amount of health and vigour for many years, and in some instances probably for the full period of human life.

THE END.

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