THE

Gulstonian Lectures.

Delivered before the President and Fellows of the College of Physicians, April, 1850.

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ON CORPULENCE.

Lecture I.

Introduction. Corpulence a TRUE *hypertrophy, distinguished from fatty degeneration. Anatomical characters of fat-vesicles; their capillaries; their nuclei and development. Uses of fat; its use in producing animal heat suggested by early physical philosophers. Aptitude of fat for its duties from chemical and physical form. Increase of bulk in adult animals mainly due to fat. Origin of fat in the body. Is it taken ready made in the food? Is it formed from other alimentary principles? Is it formed by the decomposition of other tissues of the body? Accidental cause of fat in the body; greater ingestion of carbon than is required for the respiration; influence of light.*

Mr. President,—The time spared by us from the active duty of applying our knowledge to the benefit of mankind cannot, I think, be better spent than by engaging our minds in a retrospect of the advances made in science by those whose mission it is to search out pure truth, and to whom pure truth is a final object to live for. To us, knowledge, how good and lovely soever it be for its own sake, must always be a by-end, a step merely towards the still better and lovelier goal of "good-will towards men."

Our object, then, in reviewing these researches, and in adding to them such observations as our own sphere of action supplies, should be to deduce from them rules of practice, to gather from the tree of knowledge fruit for the solace and refreshment of mankind. Such, Sir, I believe to have been the intention of Dr. Gulston in enjoining that these lectures should be physiological, and that they should be delivered by one of the junior fellows—by one whose years, indeed, will not add weight to his authority, but whose leisure will enable him to set in order the scattered leaves of contemporary literature.

I have endeavoured, therefore, to choose a subject for these lectures which should illustrate the natural transition from Physiology to Pathology, the connexion between the Laws of Life and the Laws of Death. I purpose to direct your attention to the deposition of fat in the adipose tissue, and especially to its deposition in excess—Corpulence, or Obesity. Though the exaggeration of this vital function constitutes, in itself, an actual disease, and a very common one, and its insufficiency is a sign of most derangements of our frame, yet they have received but little separate notice from practical writers of our profession. The book to which appears conceded the rank of the classical work on the subject, as far as it is connected with our profession, "Wadd's Commentaries on Corpulency and Lineaments of Leanness," was written so long ago, that to expect to throw some new light upon it is not to set up any claim to originality. Moreover, the very title of the book, like a natural human face, shows the bias of the mind within. It is so far a good title, in that we are not deceived in our expectation of finding the author possessed of those dangerous gifts, wit and satire. Were proof wanted, its pages are enough to show how incompatible such a disposition is with our calling—how ill it sits upon one to whom man has to expose himself in all his naked infirmity. The whole subject seems to be treated by all more as a curiosity than one of practical importance; and cases collected rather to furnish amusement than to increase knowledge. All description of the individuals, of their habits, their diseases, the causes of their death, is omitted, and even the stature, by which alone can obesity be judged of, is not recorded. We read in the *Philosophical Transactions* of horses' backs broken by corpulent individuals, of walls pulled down to allow exit to their coffins, of the number of men that carried them to the tomb, and such-like puerile details, but scarce a word of circumstances which, as physiologists or practitioners, we would wish to know.

Obesity, or Polysarcia, as it is called by systematic writers, must be viewed as a true hypertrophy of the *tela adiposa*—an increased growth, without change in chemical or anatomical characters. I am the more anxious to give this definition, in order to draw a strong line of demarcation between such a state and that degeneration of muscle and other tissues into fat, to which the labours of Professor Rokitansky have latterly drawn such deserved attention. He designates this as a *false* hypertrophy. "False hypertrophies," he observes, "are recognisable, at the first glance, by the alienation of the whole habit of the organ. . . . . They appear as fatty disease of the liver, as albuminous, lardaceous infiltration of the same, of the spleen, of the kidneys, ... as a change of the muscular fibrils into *molecular* fat, with destruction of the transverse striæ, and irregular distention of their sheath."* What he calls false hypertrophy is better classed by Mr. Paget as an atrophy. This last state is so entirely different from an increased accumulation of fat, that the two may be pathologically contrasted,—in *that* the substance of some necessary part of the body is removed, and replaced by a matter foreign to it; but in obesity the tissues of all the members remain intact, until at least they are overburthened by their troublesome armour.

To distinguish shortly the two kinds of fat, we will call the one found in false hypertrophy *molecular*, and the natural form, to which our attention will be directed, *vesicular* fat.

Now, where a pathological state depends on the presence of a tissue altogether improper, or improper to the place it occupies, the limits of health and disease are clearly enough defined by the eye, the microscope, or chemical analysis; but where it depends on the over-development of a normal condition, it is very difficult to draw the boundary line. Physiology is more intimately connected with morbid anatomy in this case than in the discussion of other diseases. A review, therefore, of our knowledge of the physiology of fat will be a necessary prelude to our reflections on its morbid excess or deficiency.

Fat, viewed anatomically, as a simple substance, is deposited in the animal body, not in homogeneous masses, but in vesicles specially provided for its reception. Each vesicle is a perfect organ in itself, has a distinct wall, and is supplied on its exterior by capillary bloodvessels. The perfect envelopment of the whole fat by this membrane is shown by the experiment of floating a piece of fat in water, and raising the temperature to 104° Fahrenheit, when the fat will not escape, though perfectly fluid. Its form may also be seen by placing a piece of lacerated fat on a sieve, and directing a stream of water upon it; the fat may be washed out as a fine dust, the particles of which will remain distinct, may be skimmed off the surface of the water, and dried without uniting. Their shape is round or oblong, but from compression they assume the polyhedral form which Leeuwenhoeck† has attributed to them in his engraving.

Mr. Paget‡ has pointed out an interesting peculiarity of the fat vesicles—namely, that their contents, though fluid, do not pass by exosmosis through the membranous walls. This he ingeniously explains, by noticing that the membrane is moistened continually by the same fluid which all tissues imbibe from the bloodvessels—that is, water containing albumen and salts in solution. With this the oil has no disposition to mix, and thus each drop is imprisoned in a vesicle of impermeable tissue. During life, the oil-cells, by the attraction of their walls, constantly imbibe this watery fluid from the capillary vessels that surround them, and after death, if fat be kept in or near water, no oil transudes till the cells decompose. They retain their contents on the same principle that an oil-silk bag holds water; the one is rendered waterproof by oil, and the other oil-proof by water. The fluid thus inclosed in an impermeable sac, being incompressible, is highly elastic, and diffuses pressure equally in all directions. It is similar, in fact, in its construction to a water-pillow; and is similar in its use too, for, distributed about the sole of the foot and the nates, it enables us to stand or sit with easy comfort, without the fear of squeezing out the oil from the tissue.

The membrane is supplied with this necessary watery fluid by the capillary bloodvessels, which ramify in great abundance among the vesicles, forming loops around each, and detaining the blood as long as possible in their vicinity. When the vesicles increase in number, these bloodvessels increase in number also, and appear capable of almost indefinite multiplication. How great must be the effect of this upon the circulation! If, for instance, a man of five feet two inches, whose

* Handbuch der Path. Anat., b. i. seite 72, 289.

† Philosophical Transactions, September, 1674, and August, 1722.

‡ Medical Gazette, January 24th, 1840.

healthy weight would be eight stone, increases to twenty-eight, no less than twenty stone of additional fat has to be supplied with capillaries, and those capillaries have to be supplied with blood by vessels constructed to circulate but one-third of the quantity. How wonderful must be the power of adaptation, which can render such a change consistent with life!

There is some doubt whether the adipose vesicle retains in its perfect state the nucleus of its early development. In places where fat is imperfectly formed, as, for example, in the scrotum, vesicles may be usually found containing nuclei; but in the healthy *panniculus adiposus*, or the mesentery of the adult, they cannot be detected even by squeezing out the fat and examining the empty membrane. It is possible, that when full of fat, the vesicle may contain a nucleus, hidden by the highly refractive semi-fluid secretion, or that it may be destroyed by the violent process of compression. And this view receives confirmation from the fact, that in emaciated subjects, and those affected by chronic anasarca, a nucleiform body may be found in many vesicles.* In this condition, the enveloping membrane is distended with water, and the fat floats in a yellow globule in the centre, leaving a free space between itself and the wall, and enabling us to examine the latter more accurately.

The fat vesicles are developed early in fœtal life, being found, as Dr. Lee informs me, as soon as the third month. He has seen them surrounding the nerves of the heart at that period. They are before birth, and even in the infant, very small and round, but in adult life they are of larger size, and acquire the oblong shape described.

It is clear, from what was said before about the cell membrane of the vesicles, that fat cannot be formed by a mere exudation from the bloodvessels; it must originate in a vital process of secretion, which acts in spite of the physical principle opposing the transudation of oil.

As a secretion and a constituent of the bodily frame, fat has important duties to perform. It fills up those angular spaces which the mechanical form of parts most convenient for motion leaves between them. Thus it acts as a pad on which the eye may revolve with fluency. The form of the heart, if it consisted of its muscular structure only, unfits it for moving freely in a confined space, and the periodical alterations in shape would cause a most inconvenient amount of friction. It is therefore padded into a smooth rounded form by adipose tissue. The same purpose appears to be answered by the omentum and the mesentery, by the fat vesicles in the Haversian canals of bone, and in the spinal canal, in the interspaces of the joints, in the muscles of the palm, &c.

Fat answers also the purpose of retaining warmth, and so enabling the body to be less exhausted by its exertions in the production of animal heat. Therefore are the native animals of cold regions more thickly clothed with this defence, and by the quantity of it they possess attract man's cupidity to the frozen Poles. So in winter, the hibernating animal, unable to keep up his heat by a continuous supply of food, is guarded against the destructive effect of cold by fat, and presents the anomaly noticed by the Roman poet of being in best condition when he has nothing to live upon but sleep:

> "Tota mihi dormitur hiems, et pinguior illo
> Tempore sum, quo me nil nisi somnus alit,

says Martial's dormouse.† It is remarked by Professor Barkow, that animals whose external covering protects them from cold during hibernation, lose much less weight when exposed to the air, than those whose skin is more transpirable. Thus, a snail, weighing on the 6th of January eighty-five grains, on the 2nd and 20th of February had undergone no appreciable change, and on the 8th of March weighed eighty-four grains and a half. But a toad, on being dug up, lost three grains in a quarter of an hour. A similar observation on a hedgehog showed a loss of nearly three ounces between the 19th of January and the 26th of April.‡ To prevent this loss the toad buries himself deep in the ground; and the hedgehog and the dormouse, which cannot retreat so far from the frost, are very thickly covered with fat, some of which they can afford to lose without destruction.

Fat, in these cases, besides protecting the body by its slow conduction of heat, serves as a storehouse of fuel for the respiration. When cut off from the supply of food, an animal would soon be consumed by the hungry flame of vital heat, were there not something to burn besides his own person. It affords, in fact, a power of resistance to the overpowering continuous force of one of the functions of life. Thus the tadpole, from the fourteenth day after its exit from the egg, to the time of the alteration of its respiratory organs at the period of becoming a frog, contains daily more and more fat in the abdomen, but immediately after this change all the fat rapidly disappears.* The animal would probably, without this fat, be unable to bear the strain upon the constitution which the loss of the tail must occasion. It gives him a power of resistance to the shock—a power which we may also see exemplified in our own race. For the first three days, at least, after birth, the human infant, in spite of the addition made to its substance by food, loses in weight to a considerable extent, consuming, in fact, by the novel function of respiration, matters previously unacted upon by oxygen. It is not till the fifth or sixth day that it has got sufficiently used to its new life to assimilate enough to begin growing upon.† Does not this interesting fact explain in some degree that change of feature which all must have noticed during the first week of existence?—that change, I mean, which often enables us to observe a likeness to one or the other parent in the new-born, which likeness when we see it the next day has vanished.

It was such facts as these that induced the older Greek philosophers to conjecture that the intention of fat is to sustain the animal heat by combustion, "in the same way as oil supplies the flame of a lamp, and when that flame is less powerful, less required, that the fat is laid by as in a treasure-house."‡ I quote designedly the words of Galen, that I may have an opportunity of pointing out how early Greek philosophy was in the right path of theory, and how, probably, if it had continued in that path, it would have anticipated modern discovery. But the influence of the school of Socrates, followed up by his talented pupils, Aristotle and Plato, diverted it to other subjects than the contemplation of Nature, and the consequences are here apparent. Here we see Galen, 400 years after Socrates, still led away by the verbal distinctions of his dialectic philosophy, and find him quoting, only to dissent from, an opinion due to the school of Democritus, which later times have made their own, and our generation only at length proved.§

Similar stores of fat are accumulated in the bodies of the herbivora, while the animals which feed upon them are spare and lean. The food of the horse is deficient in carbon compounds capable of absorption into his system; he can extract but little from it, however much and often he eats. If he was debarred for a short time from his pasture, the respiration must be supplied with fuel from his own substance. Fat, therefore, clothes his organs, and shields them from the consuming fire of animal heat. But the lion and the boa take in so much carbon, in a state of combination, at one meal, that the store of it in the blood suffices to prevent for a long time the combustion of the muscular fibre. They have therefore that proportionate leanness, which suits so well their active predatory habits.

It has been well remarked, that all the tissues of the animal body are, in a certain sense, excretions; the materials which

* Kölliker in Siebold and Kölliker's "Zeitschrift für Wissenschaflichen Zoologie," 1850.

† Martialis Epigr., xiii. 15.

‡ Barkow über Winterschlaf nach seinen Erscheinungen im Thierreich dargestellt. Berlin, 1846.

* Philosophical Transactions, vol. xlviii. p. 301.

† Professor Hofmann, of Munich, in the "Neue Zeitschrift für Geburtskunde. Berlin, 1849.

‡ Τοῦτον (τὸ λιπαρὸν) μὲν ἐν ταῖς τροφαῖς περιέχεσθαι, καταναλίσκεσθαι δὲ ὑπὸ τῆς ἐν ἡμῖν θερμασίας, ὥσπερ τοὔλαιον ὑπὸ τῆς φλογὸς, ἧς ἀῤῥώστου γινομένης, ἀθροίζεσθαι κατὰ τὸ σῶμα.—Galeni de Simpl. Medicam. Facult. ii. 20.

§ It is difficult to exaggerate the sad influence which the fatal talents of Socrates and his pupils exerted over the Greek mind. They turned the attention of their countrymen, and through them of the whole civilized world, to metaphysical speculation, to advance which branch of intellectual culture there is scarce a man in a century who is capable; whereas physical science can be promoted in various degrees by men of much inferior capacity. Aristophanes saw the evil in the bud, and pointed it out in his pantomime of "The Clouds;" but the attraction of apparent knowledge is too great for satire to counteract, and so men were diverted from the experimental school of Democritus, from a task in which all could have assisted, to one in which all were obliged to follow as imitators,

> "And dance, like fairies, a fantastic round,
> But neither change their motion or their ground."

There is much cant in the present day about the "enslavement of the world to gross realities," and a fear expressed lest the introduction of physical studies into our universities should add to this. Let us remember, that if this is an evil, there is an evil also of an opposite character, which checked the advance of intellect for 2000 years.

they abstract for their nutrition from the blood would, if not removed from it, be injurious. They are therefore in relation to the whole economy, excretions. This, which is probably true of all, appears most evidently in the case of oil or fat. The abstraction from the circulating fluid of this substance has a great influence over the nutritive power. Whenever it is found accumulated in unusual quantity in the blood, great disorder of the whole system always exists. Thus, it is observed in dropsy with albuminuria, where such a fatal change in the whole organism occurs, sometimes in sufficient abundance to form a thick coat of grease on the top of the blood drawn, and it almost always makes the serum milky.* It is found, also, in the blood of phthisical patients, in tuberculosis, in diabetes mellitus, in the buffed blood of inflammation, in cholera, to be appreciably increased in quantity.† Mr. Gulliver has also found fat in considerable quantity in the grey and brown hepatization of the lung.‡ As the blood is, like the Thames at London, at once the common sewer and the supplier of nutrition to the tissues, it is impossible to pronounce whether this fat is the product of decomposition, or whether it is a retained secretion; but at any rate its presence is associated with great general derangement. It is highly important that it should leave the blood as soon as possible.

In a state of health, it would appear that the fat is very rapidly separated from the circulating fluid; whatever be the nature of the food given to an animal, whether it be such as contains much oily matter, or is poor in such elements, the quantity found in the blood is not affected. Even entire deprivation of aliment does not entirely remove it where it should naturally exist, and feeding on actual grease does not increase it. M. Boussingault found exactly the same amount of oily matter in the blood of pigeons and ducks kept without food for some days as in those which had been stuffed with lard.§

We can hardly fail to admire the peculiar aptitude for the duties assigned to it which is displayed by the chemical and physical form of fat. In the first place, its insolubility in water prevents it from transuding through the walls of the containing cells, and so being dissipated through the skin. The same insolubility prevents it also when in the blood from being carried off by the kidneys, and enables it to be retained as a treasure of fuel to the animal economy. The great amount of carbon and hydrogen which enter into its composition makes it exceedingly useful as an excretion, in removing from the blood these elements. And the same carbon and hydrogen fit it peculiarly for supporting combustion, by union with the oxygen of the air, when it is required by the wants of the system. But yet, though capable of oxydization by conversion into carbonic acid and water, it does not so readily undergo that change by organic fermentation as some other organic compounds usually present in the body: not so readily, for instance, as the starch and sugar introduced to the blood by the food, in which the oxygen and hydrogen are present in the proportions requisite to form water, and in which therefore the decomposition is simpler. This relative inferiority of oxydizing tendency fits it for being a store in reserve, which will not be used so long as other materials are present.

The union of the several forms of oily acids with the same base is an advantage, in that it causes them to be acted on by similar reagents, and therefore renders their mixture in different proportions, to form hard and soft fat, more permanent and convenient.

The close relation which its forms bear to one another, and their easy conversion by the loss or gain of certain quantities of oxygen, is an interesting point. Thus elain may be converted into stearin by the formation of water and carbonic acid.‖ Carnivorous animals, whose fat consists principally of margarin, gain that fat by feeding on the bodies of grazing animals, in whom stearin and no margarin is found. On the other hand, the ox takes the margarin of the oil-cake, and converts it into suet.

(To be continued.)

* Milky serum, however, does not always depend entirely on globular fat. It sometimes is not soluble in ether, and has a form under the microscope different from oil. Rokitansky suggests that it may in such cases be a form of fibrin.

† Hofmann's Grundlinien der Phys. Chimie, p. 202; and Rokitansky's Path. Anatomie, b. i. p. 515.

‡ Medico-Chirurgical Transactions, vol. xxvi. Feb. 28, 1843.

§ Annales de Chimie et de Phys., vol. xxiv. p. 460.

‖ Beetz, Ann. der Chimie, 1843, p. 232.

SURGICAL CASES.

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(Continued from p. 500.)

Membranous croup; impending asphyxia; laryngotomy; death from convulsions.

Case 3.—I was requested by my friend, Mr. Greenhalgh, on the evening of the 22nd of January, to see a little girl, five years of age, who had been under his care for two days with symptoms of croup, which had, rather suddenly, assumed so severe a form as to threaten immediate suffocation. As the child lay in a state of stupor, and was becoming rapidly asphyxiated—as the whole of the obstruction to respiration appeared to be seated in the larynx, the lungs being pervious throughout, and as treatment of a very active character, such as leeching, antimonials, and calomel, had been had recourse to without arresting the disease, we agreed that the only chance of saving life consisted in making an opening into the air-passages, in order to give time for the disease to be combated by active treatment. As the case was urgent, and it was desirable to open the air-tube with as little delay as possible, I at once cut down on the crico-thyroid membrane. There was tolerably smart bleeding, but this was arrested, in a great measure, by ligaturing a small arterial twig, that was pumping out black blood, and by pouring cold water into the wound for a minute or two. The membrane was then punctured, and a silver tube introduced. The breathing became at once relieved, consciousness returned, and the child's condition became greatly improved. The calomel treatment was continued, and she went on very well, until about twelve o'clock on the following day, when she was seized with a fit of convulsions, (to which she had formerly been very subject, having at one time had hemiplegia,) which, after continuing for three hours, terminated fatally.

Examination twenty-five hours after death.—The larynx was found almost completely filled up by masses of opaque, white, false membrane, which were accumulated in largest quantity about the ventricles. The edges of the glottis were swollen and œdematous; the submucous cellular tissue being much infiltrated with serum in this situation. There was also some infiltration and œdema about the anterior aspect of the epiglottis. The mucous membrane of the trachea was reddened and inflamed, with, here and there, a small, thin patch of false membrane, not in quantity sufficient to give rise to any obstruction to the entry of air into the lungs. The lungs were very slightly engorged posteriorly, but were perfectly crepitant throughout. The opening in the crico-thyroid membrane was altogether below the seat of obstruction.

It is, I believe, but seldom necessary to make an opening in the windpipe in croup, and the result of those cases in which such an operation has been performed, is not sufficiently favourable to lead to the practice becoming general; but yet cases do occasionally occur, in which the risk of immediate suffocation is so imminent, the obstruction so clearly confined to the larynx, and the lungs and bronchi apparently so free from inflammation, that the practitioner may feel himself justified in making an artificial aperture into the air-tube, in order to allow time for treatment to have effect. In those instances of membranous croup in which an operation is determined on, tracheotomy is almost invariably preferred to laryngotomy, on account of an opening in the trachea being more likely to be below the lowest limits of the membranous deposit than would one in the crico-thyroid membrane. No doubt, this is a sufficiently valid reason for preferring the low to the high operation in those cases in which the risk of *immediate* suffocation is not great. But if the patient be in a state of almost complete asphyxia, in such a condition that every minute is of importance, the delay of a few moments being sufficient to terminate existence, as in the child whose case has just been related, that operation should, I think, be had recourse to which can be most quickly performed. For not only is it of much consequence to admit air as rapidly as possible into the lungs, but also to avoid anything like a prolonged struggle. A struggle, or, indeed, movement of any kind, tends greatly to increase the embarrassment to the circulation that exists in asphyxia, and may arrest at once the already enfeebled action of the heart.

Now, in children, tracheotomy is almost always a tedious operation, the exposure of the trachea requiring a careful dissection, and much time often being lost before it is punctured, owing to the free hæmorrhage that usually occurs.