An Inquiry

INTO THE

NATURE OF THE CHANGES CONSTITUTING FATTY DEGENERATION OF THE HEART.

BY

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In the medical address delivered at Cambridge last year, I endeavoured to shew that fatty degeneration of the heart was a pathological and not merely a chemical process imitable in the laboratory by artificial means. The experiments then adduced seemed fairly to justify the conclusions:—1. That fatty matter cannot be made from the muscular tissue of the heart by any of the received processes for converting animal substances into adipocere; indeed, that, on the contrary, the fatty matter of adipocere is derived from the fat already existing in the tissues operated on, and is not a newly formed substance. 2. That though the first stage in fatty degeneration and chemical decomposition be the same, both alike inducing so-called granular degeneration, yet that, so far, there is no fatty formation in either process.

The present inquiries were instituted with a view to determine more exactly the nature of this granular degeneration. In the first instance, my attention was directed to the muscular structure of the heart, as the tissue in which granular degeneration is most characteristically displayed. A more extended observation, however, seemed to show that the laws of degeneration are the same for both species of striated muscular fibre, the voluntary muscles and the heart alike. The results indeed are modified by the structural differences between the two kinds of fibre to a certain extent; but these very differences, instead of disproving in any way, rather help to prove more clearly the general identity of the process of degeneration in them both, allowing us to test the correctness of our conclusions by reconsidering them from a different point of view.

It is, however, rather as supplementary to the observations on the heart, than as having an independent value of their own, that I have brought forward any observations on fatty degeneration of the voluntary muscles. Our knowledge of this subject is as yet imperfect, as regards the mutual relation in which the successive changes stand to each other. However distinctly we may recognise the several phases, we cannot yet arrange them so as to present a continuous history of the disease, from its first beginning to the complete obsolescence of the muscular tissue. Their pathological meaning, too, is not altogether clear at present. Perhaps they may express merely fatty degeneration; but their frequent connection with typhus, as Dr. Zenker has shown in his admirable monograph (*Die Veränderungen der Willkürlichen Muskeln in Typhus Abdominalis*), and with cancer, as he generously reminds us that Dr. Bennett (*On Cancer*, p. 105) had previously noticed, favours the belief that they may have some special connection with particular forms of disease; and at least there is need of more observation to bring our know-

ledge of the microscopic pathological anatomy of voluntary muscle up to the level of that of the muscular structure of the heart.

Fatty degeneration of the muscular fibres of the heart commences by a change known as granular degeneration. I believe that the term granular disintegration would more correctly express the nature of this change; for the appearance is due to a disintegration or disruption of the sarcous elements contained in the primitive fasciculus. This is the first step towards fatty degeneration. It may be induced by other than pathological causes; namely, by commencing putrefaction, and by decomposition under artificial conditions. The arrangement by which the natural process is most readily imitated, is a prolonged maceration in dilute alcohol. By this the sarcous elements are disintegrated along the longitudinal lines of cleavage—to adopt Mr. Bowman's nomenclature. By prolonged maceration in dilute nitric acid, disintegration is effected in both the longitudinal and transverse directions, and the fasciculus is resolved into small squarish powdery fragments. By varying these processes the results may be modified; and by such means the muscle may be disintegrated or disrupted at will, in either direction and to any extent, independent of any fatty degeneration. And we may thus obtain an insight into the nature of the pathological process, where, from the disintegration not having been pushed as far as in our chemical experiments, the appearances are more equivocal.

The granular fasciculi which result from the pathological process, or from any of these chemical reactions pushed only so far as to imitate it, require a high power to display the exact nature of the changes which have taken place. With a magnifying power of about 240 diameters only, it seems as if the transverse striæ had been replaced by longitudinal rows of dots, divided here and there by other rows of larger and darker dots, and by fine lines. These appearances are explained by the application of a power of 450 diameters or more, which shews that the transverse striæ are not really lost. They are paler indeed than in the normal condition, but they preserve their normal distance from each other. The primitive fasciculus seems to be split into ribbons of unequal width by longitudinal fissures interrupting the transverse striæ. In consequence of these interruptions, such striæ as catch the eye with a lower power seem to run into rows of dots, and this false impression is heightened by the rows of larger and darker dots which occupy some of these longitudinal fissures.

The examination of this altered structure of the heart is much facilitated by the use of glycerine, according to Dr. Beale's directions. Unfortunately, this medium, so very useful in unravelling the fasciculi, greatly obscures their transverse markings. But this is remedied to some extent by the application of ether, which dissolves away the large dark dots in the fissures, and brings the transverse striæ again into view, drawing them at the same time nearer to each other, so that eight now occupy the space where only six were found before the ether was applied. As the various objects in the field come out more distinctly, some longitudinally striated fasciculi may perhaps be recognised among the degenerated fibres; and from the ends of some of these which have been broken during the manipulation, ragged filaments may be seen projecting, just as in degenerated voluntary muscle. These filaments vary in length and breadth, but all have the transverse markings; some are broader; some so fine that they might be fairly said to represent the old so-called ultimate fibre of muscle, their dimensions scarcely admitting of the presence of more than a single row of the component

granules. It is scarcely necessary to remark that, though the demonstration of these changes is facilitated by the use of these reagents, the changes are wholly independent of their employment. Without the use of ether, the transverse striæ may be brought again into view by means of a condenser and a narrow stop.

As the process of degeneration advances, the longitudinal fissures become fewer and more distinct, and the granules, too, larger, fewer, and less regularly arranged in rows. All traces of transverse striæ disappear, the longitudinal markings fade in the progress of the disease, and the primitive fasciculus now appears as a granular mass, preserving only its original outline. Now fatty degeneration has fairly begun, and oil globules are to be seen in and about these altered fasciculi, apparently resulting from the coalescence of the larger, darker dots above mentioned.

Life does not last long enough with a heart thus involved, for one to be able to say exactly what is the ultimate end of fatty degeneration of its muscular structure. The disease will generally be found to have advanced furthest in the little pale specks to be seen on the inner surface of the left ventricle. Here single fasciculi sometimes present partial dilatations, but more commonly they shrink away. Bundles of irregular shrunken fibres, which occur in connection with fatty degeneration, or the cicatrices which appear to the unassisted eye, may probably represent the obsolete muscular fibres in which this process has been completed. But this termination of fatty degeneration is more familiarly known in the voluntary muscles. In one bundle of the heart's fibres, as in a single voluntary muscle, there is nothing to hinder the completion of the process; but, as might have been anticipated, the more widely the degeneration is diffused through the heart, the less progress will it be found to have made.

The ultimate results are mostly the same, whether the disease commenced, as is usual, from the interior of the heart, and in connection with cachexia or anæmia, or whether it have originated in inflammation and have started from the outside. But the steps of the process, or at least the collateral phenomena, are not absolutely identical in all these cases. In fact the specific pathological influence does not seem always to cease with the first injury to the fasciculus. But the exceptions to the ordinary mode of progress of the disease requiring particular notice are not many.

One striking exception occurred in a poor girl who died of pyæmia. In the muscular structure of her heart were red patches, looking like ecchymoses, of a deep purple mixed with grey in the centre, becoming gradually paler at the edges. In the grey part there was a mixture of pus and blood, with fragments of muscular fibres. Surrounding this was a zone, in which the muscular fasciculi had lost all traces of striæ both transverse and longitudinal; they were simply granular all over. Then, for a space, the fasciculi were longitudinally striated, as in degeneration of the voluntary muscles. Outside this the muscular structure presented the normal appearance. Within the radius of two or three lines the chief appearances of degeneration of voluntary muscle were perfectly reproduced in miniature. The only character which was not adequately represented here, namely, the redundancy of small nucleolar bodies, was very strikingly shewn in the heart of a boy who had fatty degeneration commencing from the outside, consequent on rheumatic carditis.

Generally, it may be said that the process of fatty degeneration of the voluntary muscles is the same as that of the muscular structure of the heart. Yet

there are readily appreciable differences in the details of the process in these two tissues respectively. These differences seem referable to a certain extent to the structural differences of the fibre, and notably to the greater development of the sarcolemma in the voluntary muscles. The first stage of fatty degeneration of the voluntary muscles, as far as I have been able to satisfy myself, is characterised by swelling of the affected fasciculi. For a greater or less length they appear uniformly dilated to about twice the size of the healthy fasciculi, smooth on the surface, seemingly wanting the transverse striæ, but streaked longitudinally; and from the broken ends of each such fasciculus loose strings hang out like the strands of a rope, as if it had undergone thus far, complete longitudinal disintegration. A higher power shews here, as in the muscular structure of the heart, the existence of the transverse striæ, only paler than natural. They are not interrupted by the longitudinal markings. They are approximated to half the normal distance, sixteen of them occupying the same space as eight do in a healthy part. Ether does not cause them to approximate more closely, though it seems to shrink up the fasciculus; and it displays the longitudinal markings very clearly, at the same time that it extracts fatty matter from its interior.

This longitudinal cleavage would seem to hold nearly the same relation to fatty degeneration of voluntary muscle, as granular disintegration does to that of the heart. Nearly, for it passes more directly into fatty degeneration than the corresponding change in the heart does, ether readily extracting oil from the streaked fasciculi. And it is more specifically a pathological process, being much less readily imitable by any artificial reactions. For chemical decomposition and putrefaction do not induce this particular appearance, but seem, as far as I have observed, to pass over it to a further stage, converting the fasciculus into a finely granular mass, which retains only the outline of its former structure. This process of conversion may be traced in some of the transverse striæ which have survived the rest. These appear distinctly granular, broad, and uneven; as if falling to pieces under the action of the dilute nitric acid, which has disintegrated the sarcous elements elsewhere. The striæ seem to persist longest just beneath the sarcolemma. Some fasciculi which appear granular, owe this deceptive appearance to the striæ on the two opposite sides of the flattened fasciculi crossing each other diagonally, the regular arrangement persisting on the surface for a while after the sarcous elements in the interior have been deranged or dissolved entirely away.

Sometimes these large, pale, waxy-looking fibres occur alone; more commonly, however, broken fragments of fibres are found mixed with them, swollen, like them, to twice the size of the neighbouring healthy fasciculi, but marked in a different way. Some of these are minutely granulated, the fasciculi thus marked being much more brittle than those which are longitudinally streaked. Others are neither granulated or streaked, but cracked or broken transversely, and often connected at either end with a string of sarcolemma, as if they had partially escaped from their investing membrane. They have a singular affinity for the colouring matter of carmine, which tints them more deeply than any of the other structures which the altered tissue presents. Besides these, the field appears to be sprinkled over with little nucleolar bodies, some few of which are the nuclei of the muscular tissue; others, more numerous, are apparently the rudiments of fibro-cellular structure; others are of uncertain nature; and many are undoubtedly collections of oil-globules, arranged like rows of squarish beads. These are removed by

ether, which clears the field a good deal, while acetic acid has very little effect in this way. And with these are a number of loose oil-globules, which have been set free during the manipulation of the tissues. The changes which occur in connection with typhus, as figured by Zenker, are precisely those which I am now speaking of as constituting the various stages of fatty degeneration. (Taf. iii, figs. 1-2; taf. iv, fig. 1.)

Not to lengthen these remarks needlessly, I may yet venture to add, in a few words, to this statement of facts, the conclusions which seem fairly deducible from them.

I believe that the first step towards fatty degeneration of muscular tissue is disintegration of the sarcous elements into filaments or discs, as circumstances may determine. The actual fatty degeneration is secondary to this, and is a consequence—not a cause—of the disorganisation (the functional death) of the fasciculus. In the further changes and ultimate obsolescence of the fasciculus it may play an important part, particularly by resolution of the sarcous elements in the oily matter infiltrated among them through the sarcolemma; but the disorganisation of the part precedes its degeneration.

Inflammation, anæmia, cachexia, want of nutrition, and all the other causes to which fatty degeneration of the heart has been ascribed, have thus much in common that they disorganise the muscular tissue. The disintegration and the fatty degeneration which ensue, may be modified by the abiding influences of the original exciting cause of the disease, but they are transacted by the ordinary agency of the living body quite irrespective of these various possible causes. The actual fatty degeneration depends on the amount of fatty matter in the blood available for this purpose; and it is conceivable that, for want of an available supply of fatty matter, disintegration should not be followed by fatty degeneration at all. Indeed, this seems actually to occur sometimes; the change under certain circumstances does not pass beyond the stage of so-called granular degeneration.

Now, if this be true, a question suggests itself, whether this explanation be limited to fatty degeneration of muscular tissue, or whether it has a wider bearing. For instance, is fatty degeneration of the liver or kidney an infiltration of disorganised cells with oily matter, or a destructive accumulation of oil in healthy cells? Further, is the physiological accumulation of fat in adipose tissue explicable on the same principle, namely, that healthy cell-walls, sarcolemma, or other such tissues are impermeable to fat, and that the accumulation of fat in any part implies that the vitality of the tissue containing the fat has been lowered?

I am not prepared to offer any answer to this question at present. It demands as particular an inquiry into all possible cases of fatty accumulation and degeneration, as I have endeavoured to carry out in respect of the single case of the heart. Beyond all others, the instances of acute fatty degeneration of the brain and liver need careful investigation, more than those where this principle obviously applies. The study of these and such instances is more likely to lead to a just estimate of the value of this principle, than an accumulation of cases where the facility of its application tends to conceal its deficiencies.

TYPHUS IN MALTA. A severe form of typhus fever has lately been very prevalent in several of the country districts in Malta. Its virulence has now abated; and, from a report made by order of the Governor, it appears that it was due to overcrowding in ill-ventilated apartments.

Original Communications.

VENESECTION IN DISEASE.

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THERE is an old and very true saying, that no reputation is better than a bad one; and the saying precisely fits the article venesection, as a remedy in disease. The true estimation of this remedy is, I am satisfied, not admitted, mainly because of the evil reports which attach themselves to the word through its historical connexions. I have no doubt whatever, that if venesection were a modern invention, it would be in much more frequent use than it now is. The remedy thus suffers; and in two ways.

1. The proper uses and right application of venesection are not generally recognised, because the erroneous idea which was attached to its employment in past days is still very much attached to it now; viz., the idea that by its use the supply of aliment to the fire which is raging in and consuming the inflamed structure is cut off.

2. It seems to be still generally assumed, as it was in former days, that the use of venesection is synonymous with the disuse of what are called restoratives; and that those who employ venesection must, of necessity, also at the same time employ low diet, purgatives, and whatever else is comprised under the old idea of antiphlogistic.

So long as these erroneous ideas, which naturally run together in men's minds, prevail; so long as venesection and low diet are regarded as things necessarily connected; so long as venesection is employed with the idea of directly controlling the inflammatory process *in loco* by cutting off the fuel which feeds the flame—so long, in my opinion, will venesection be in bad repute.

My distinguished friend, Professor Bennett of Edinburgh, has not altogether emancipated his mind, as it would seem, from the ideas here referred to. In a very instructive paper lately written by him, On the Treatment of Pneumonia by Restoratives—a paper which appears to have been called forth by a lecture on Venesection by myself lately published in these pages—Professor Bennett gives the result of his long experience in the treatment of pneumonia. He does so to show the good effects of the restorative treatment; and because he observes, “that an effort is being made to restore the dangerous practice of bleeding in pneumonia.”

Perhaps, in the lecture referred to, I somehow failed to make my meaning clear. I would, therefore, in explanation, wish to say, that Professor Bennett has quite misinterpreted my meaning; and that I really believe there is *au fond* very little difference of opinion between us as to the practical use of venesection in pneumonia.

In the first place, I have not recommended venesection as a cure for pneumonia. According to my views, venesection has no directly beneficial influence over the local inflammation, and is not used to cure the pneumonia; but solely and wholly to relieve certain accidents which have arisen out of the pneumonia; viz., the congestion of the heart and of those portions of the lungs which are not the seat of inflammation. To administer restoratives, therefore, both before, during, and after the venesection, is a perfectly legitimate practice. To suppose that the employment of venesection means the non-employment