ON
THE SOFTENING
OF
COAGULATED FIBRINE.

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THE nature of many of the albuminous morbid products affords an extremely interesting subject for further inquiry, since it is probable that a great step in the advancement of pathology may be dependent on the acquisition of a more precise knowledge of their distinctive characters. Although these matters differ most remarkably in their consequences, and are apparently developed in the living body under conditions essentially distinct,—seeing that they have properties more or less analogous to those of albumen—M. Andral, and most of the pathologists of the French school, have earnestly insisted on this analogy, with the view of informing us, that the substances in question are nothing but a modification of one of the proximate principles of the blood.

It is possible, however, that this kind of generalization may be premature, and it seems doubtful whether, by attaching too exclusive an importance to rather vague generic characters, it may not have tended to retard that more particular examination of these substances, still so essential to a satisfactory knowledge of their intimate constitution ; for, in the present state of pathological science, it is with their specific differences that we require to become acquainted ; and their affinity to albumen, and common points of resemblance, so far from leading us to this desirable end, present the greatest difficulty in the investigation.

Of all these products, from its constituting one of the most frequent elementary forms of disease, pus is the most important ; and as various matters have been comprised under this denomination, some investigation of their peculiar properties would appear to be necessary. Hence any contribution towards this object will not perhaps be altogether unacceptable, and I therefore beg to submit to the Society a narrative of some experiments and observations from which it may be concluded that a fluid which has generally been described as purulent is, notwithstanding, of an essentially different nature. I have elsewhere* mentioned incidentally that this matter is softened fibrine, and I now adduce the evidence on which that opinion was founded, together

* Researches on Suppuration. Philosophical Magazine : September 1838.

with such remarks as may appear necessary by way of illustration.

1. *On the Concoction of Fibrine.*

EXPERIMENT I.

A clot of fibrine, such as is so often found there after death, was taken from the heart, and carefully secured in a perfectly clean portion of small intestine turned inside out, so that the fibrine was in contact only with the peritoneal surface of the gut. It was then placed in a water bath, and kept for forty three hours at a temperature varying from 96 to 104 degrees, when the fibrine was found to have become partially softened, particularly in some places towards the centre. It had rather an offensive, though not at all a putrid odour, and no ammoniacal gas appeared to be emitted from it, judging from the test of muriatic acid.

About a drachm of the softened fibrine was collected for examination. It could not have been distinguished from pus either by its colour and consistency, or by the facility with which it was miscible with water ; it was not rendered ropy by caustic volatile alkali, and presented no iridescence when pressed between plates of glass before a candle in the manner pointed out by Dr. Young. Subjected to the microscope, the fluid was found to be loaded with particles extremely variable in size and form ; some appeared very dense, others were flaky and larger

than pus globules, but the greater number were smaller, extremely irregular in shape, not at all globular, like pus, but consisting of very minutely granular masses, and a few rounded particles about half the diameter of those of the blood were observed. On the addition of acetic acid all the particles soon disappeared, except a few which seemed more compact and required a longer time for solution. Treated with sulphurous acid, they swelled considerably, and became nearly invisible. Some of the softened fibrine was put into a small vial of water, a similar quantity of the clotted fibrine which had not been concocted being in like manner placed in another vial. Both were set aside for four days, the temperature of the air at the time ranging from 60° to 74°, when the mixture with the concocted fibrine was but very faintly putrescent, and that in the other bottle highly so.

EXPERIMENT II.

A coagulum of fibrine from the heart was concocted at a blood heat for sixty-five hours. The entire circumference was reduced to a pulposus substance in every respect similar to that just described, except that slight putrefaction had commenced, and a number of very minute globular particles, hardly one third the size of the blood corpuscles, were observed, exhibiting lively motions on their axes, as if animated.

EXPERIMENT III.

Some fibrine from the heart was inclosed in a glass tube, and subjected to a blood heat for seventy-four hours. A fluid resembling pus was the result, but differing from pus, as in the former instances. It had begun to putrefy : a small quantity was put into a vial, and a little of the clot which had not been concocted into a another bottle. Both were set aside for five days, when the latter had become highly putrid ; and the former only faintly so. The temperature of the air was about 65°. On examining the concocted fibrine at this time with the microscope, numerous very opaque, and slightly oval particles were seen, not above $\frac{1}{10000}$ th of an inch in diameter, and at the end of seven months they were observed again unchanged, the fluid having been kept in a corked vial. These little bodies did not exist in the fibrine which had become putrid without artificial heat.

EXPERIMENT IV.

Some fibrine was obtained from venous blood by agitation in the usual manner, and the colouring matter washed away, though not completely so. After being inclosed in a glass tube and concocted for seventy-one hours, a fluid matter was produced, of the consistency of thin pus, but of a reddish colour. It had begun to putrefy ; it was faintly iridescent when submitted to Dr. Young's test ; several

globules were observed with the microscope, all smaller than those of pus, the largest not exceeding $\frac{1}{4000}$ th of an inch in diameter, and the smallest measuring about $\frac{1}{8000}$ th. The former were rough on the surface; the latter regularly spherical: they all disappeared on the addition of oxalic or acetic acids. The mass of the fluid was constituted as described in the first experiment.

EXPERIMENT V.

With a view of counteracting the effect that oxygen might have in promoting putrefaction, several clots of fibrine were concocted in vials with phosphorous or with zinc, which were so attached to the corks as not to be in contact with the fibrine. Although the vials were hermetically sealed, the softening of the fibrine went on during the coction as in the former experiments, the pulposus matter presenting the same characters as in the first, with the exception of emitting a much more offensive odour.

EXPERIMENT VI.

Some of the fibrinous concretion formed, in consequence of inflammation, on the pleura of a dog, was confined in a glass tube, and subjected to a blood heat for eighty-four hours, when it was found to be throughout softened, and presenting just the colour and consistency of pus, from which however it was easily distinguishable by the characters noticed in the other trials.

EXPERIMENT VII.

A fibrinous clot from the heart having been concocted for seventeen hours, was found only to have become slightly whiter, tougher, and more opaque, than at first.

*2. Softened Fibrine in the Heart and Aorta.**CASE I.*

A lunatic named Winkworth, aged 58, of the 2nd garrison battalion, died of pulmonary consumption. Among the *calumnæ carneæ* of the left ventricle, several clots of fibrine were situated, containing a pulposus creamy matter in their centre. This was not iridescent when submitted to Dr. Young's test; it became nearly transparent when treated with acetic acid; it was not rendered ropy by ammonia or the muriate of this alkali.

CASE II.

J. Cowan, 56th regiment, aged 29, died of pulmonary consumption. Some fibrinous clots were found among the fleshy columns of both ventricles, similar concretions of smaller size were attached to the inner membrane of the descending aorta, and some of the smaller branches of the pulmonary artery were filled with coagula. All these clots were more or less softened in the centre, the surfaces of those

in the heart and aorta being toughish and cyst-like. The matter resembled pus in colour and consistency, but differed from it in being composed of very irregular particles and a few extremely minute globules, all readily soluble in acetic acid, swelling and becoming indefinite under the action of sulphurous acid, and not iridescent when placed before a candle. In short, it was destitute of pus globules, and presented just the same characters as the softened fibrine described in the first experiment.

CASE III.

James Cumming, aged 29, 86th regiment, died of lumbar abscess, complicated with tubercular consumption. Two fibrinous concretions, as above described, and similarly softened, were found in the left ventricle, and the examination of the creamy matter gave the same results as in the preceding case.

CASE IV.

John Owen, aged 29, 86th regiment, died of pulmonary consumption. Some fibrinous clots, irregularly softened, were attached to the inner surface of the right ventricle, and others of smaller size to the internal membrane of the aorta; the latter were softened in the centre. The matter presented the same characters as in the other cases.

3. *Softened Fibrine in the Veins.*

CASE V.

Cornelius Murphy, aged 39, 44th regiment, died of pulmonary consumption. Both the femoral veins were occluded with coagula, which, in some situations, had become of a whitish colour and softened towards the centre. The fluid was composed almost entirely of irregular particles soluble in acetic acid, and had none of the properties of pus but its colour and consistency.

CASE VI.

John Edwards, aged 21, 41st regiment, died of empyema. Both femoral veins were filled to a considerable extent with coagula, which had become partially white in some places where there was central softening, the matter exactly resembling that noticed in the former case.

CASE VII.

William Edwards, aged 25, 86th regiment, died of pulmonary consumption. The right iliac vein was filled with a firm clot, in the centre of which was some softened fibrinous matter, of the same characters as previously mentioned.

CASE VIII.

Corporal Pat. Long, aged 35, 86th regiment, died of chronic dysentery ; the large intestines were ulcerated, but no collections of pus could be detected in any part of the body. The cava, renal, femoral, and saphena veins were completely filled with a clot, which in the former had become softened in the centre, the fluid being of a reddish brown colour. It was faintly iridescent, and observed under the microscope to be composed principally of very irregular particles, similar in all respects to those of softened fibrine, but pervaded also by a considerable number of globules, somewhat smaller than those of the blood, pretty regular in size, and rough on the surface. On the addition of acetic acid or carbonate of ammonia they instantly disappeared, and the irregular particles were slowly dissolved in the acid.

CASE IX.

John Smith, aged 18, 17th Foot, died of peritonitis : there was a purulent collection between the duodenum and liver. The longitudinal sinus was filled with a clot, in which there was central softening, the matter presenting in all respects precisely the same characters as in the preceding case.

The foregoing experiments and cases are selected
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from a much greater number, which it is needless to detail, since they all tend to the same result. It should be noticed that the softened fibrine was, like pus, generally easily miscible with water, but more readily putrescent than pus, although less so than the fibrinous coagula which had undergone no change. Among the numerous instances in which fibrine was submitted to concoction, there was only one in which softening towards the centre of the clot was observed. It is prone to occur in this situation in the living body, perhaps because the centre is the most distant point from the living parts ; for it will appear in the sequel, that an extremely low state of the vital powers is favourable to the formation and softening of the coagulum.

The fibrinous pulp in the veins was sometimes sparingly pervaded by globules differing from those of pus, in being smaller and readily soluble in acetic acid, or solution of ammonia. They closely resembled the appearance of the blood corpuscles when about to putrefy, that is, rough on the surface, or mulberry-shaped, as if each were composed of a number of smaller granules. Considering, therefore, the characters of these globules,—that they were not often met with, and that when they were they by no means formed the principal bulk of the pulpous fluid, so far from being essential to its consistency and opacity, they are rather to be regarded as a few blood-corpuscles retained in the clot, and modified by stagnation and concoction. However, as it not

unfrequently happens that the clot becomes softened before the colouring matter is absorbed, or the fibrine separated from the blood-corpuscles, the pappy portion in such cases will be more or less tinged in consequence, and the globules in question may be found more abundantly. They occur very rarely in the clots of the heart, where the fibrine generally separates more completely from the corpuscles. Most of the cases which I have observed in the veins have not presented marks of inflammatory action in the coats of the vessels, such as roughness of the inner membrane from adherent coagulated lymph, or increased vascularity or suppuration in their cellular sheaths. The softening of clots of fibrine appears, indeed, to be independent of inflammation, although this process and its consequences may be expected to occur sooner or later in the neighbourhood, and we may accordingly find true purulent fluid mingled with the softened fibrine, just as we often observe pus with cancerous and tubercular matter.

It may be observed that the softening of fibrine certainly occurs sometimes without appreciable suppuration in any part of the body. I have seen such cases, and Dr. Davy informs me that he has witnessed similar instances.

Although the occasional obstruction of the veins by sanguineous coagula, whether softened or not, has become of late years well known from the labours of the continental pathologists, and particularly in this country from several reports of dissections in the

magnificent work of Dr. Bright, as well as from the essays of Mr. Arnott, Dr. Geo. Burrows, and Dr. Copeland, my observations lead me to believe that the affection is not only more frequent than is generally supposed, but more concerned in disease, a circumstance to which my attention was first directed by Dr. Davy. Those who have not been in the habit, when examining dead bodies, of accurately attending to this point, would be surprised at the numerous examples of this condition noted in the register of dissections made under his superintendence at Chatham. The clots were in most instances partially whitened and softened in the centre; they were found in the heart, and also adhering to the inner membrane of the aorta; in the veins of the lower limbs, as well as in the cava, portal, and renal veins; in the pulmonary vessels, and in the sinuses of the dura mater. They were chiefly observed in subjects who, having long suffered from various chronic maladies, had great prostration of the vital powers, and languor of the circulation during the last days of existence; a state which was also remarkable in the cases related in this paper, and which seems especially favourable to the formation and softening of the clot. If, therefore, a vein becomes obstructed with coagulated blood or fibrine, which cannot easily be absorbed or organized in consequence of the very feeble vitality of the patient, the clot may be expected to soften, and it is accordingly in such cases that the affection may be often

found after death, although never suspected during life.*

On the contrary, when the organic force is active, we know how readily fibrine becomes the seat of new formations, that it will acquire firmness and remain for years in the sac of an aneurism, and that extravasated blood is generally soon absorbed after injuries. In repeating those experiments of M. Gendrin, in which a seton is passed through a clot of blood, either in or out of the vessels, I could only twice succeed, after numerous trials, in producing any thing like pus in the substance of the coagulum. In these instances the animals were greatly reduced from the effect of previous operations, and the matter proved to be nothing more than softened fibrine, such as I have described it. When blood was injected into the subcutaneous cellular tissue, or into the serous cavities, its complete coagulation was retarded for two or three hours, while some of the same blood kept at the animal temperature in a bottle always coagulated in less than eleven minutes. Absorption of the clot took place with great rapidity, and was hardly delayed by passing a seton through it, so that on the second or third day it had nearly disappeared,

* The cause and effects of the coagulation of blood in the heart and vessels during life, and the connection of the phenomenon with disease, as well as the changes to which the clot becomes liable, and the effects of the mixture of the softened fibrine with the circulating blood, are all subjects full of interest and importance, requiring further inquiries.

the threads approaching the skin, where of course pus would be formed independently of the extravasated blood. When two ligatures were so placed on a vein as to include an inch or two of the column of blood, it took about three hours to coagulate perfectly, as Sir Astley Cooper had noticed in his experiments. In two or three days it lost its colouring matter, becoming whitish, tolerably firm, and shrunken. After a seton or a leaden shot was put into the clot, no appearance of a purulent-like fluid was seen towards the centre, although pus was frequently present between the coagulum and lining membrane of the vessel, and still more often in the cellular coat and neighbouring parts.

It may be observed, therefore, that as the doctrines of M. Gendrin concerning suppuration, have been extensively promulgated in almost every work on the subject recently published in this country, the preceding cases are interesting in this respect, since they are of that species to which he attaches so much importance, as proofs of the conversion of clots of fibrine or blood into pus. However, as Mr. Palmer remarks, M. Gendrin appears to have confounded the fibrine and corpuscles in a manner not consistent with the known constitution of the blood; and although some purulent or other matters may be occasionally mixed with the softened fibrine, still as it results from several observations that the latter is essentially distinct from pus, and constitutes the whole or greater part of the so-called purulent fluid

in these cases, it is at least doubtful whether they admit of the inference which M. Gendrin has drawn from them.

The experiments and observations recorded in this paper appear to admit of the following conclusions :—

1st. That coagulated fibrine, when removed from the body and subjected to a blood heat, commences to soften in about forty hours, assuming the colour and consistency of pus, but easily distinguishable from it by microscopic and chemical examination.

2nd. That the purulent-like fluid found in the fibrinous clots of the heart and arteries, and so frequently in the veins, is essentially distinct from pus, and analogous to, if not identical with, softened fibrine.

3rd. That the softening of coagulated fibrine is an elementary pathological condition of frequent occurrence, distinct from suppuration, and constituting a considerable proportion of the cases generally denominated suppurative phlebitis.

Lastly, I may observe, that I have frequently found pus mixed in considerable quantities with the pulpy fibrinous matter ; and in two instances some purulent globules were observed, completely insulated, in the centre of a clot, from the neighbouring tissues. But in both these cases pus was also detected in the blood ; and when it is considered how frequently this contamination exists, it will not appear surprising that the particles of pus should become entangled in coagula contained in the vessels.

Nor does this circumstance at all invalidate the conclusion, that the softening of coagulated fibrine is a disease of much interest and importance, quite distinct in its nature from suppuration, although the two affections have been generally regarded as identical.

Windsor, January 23, 1839.