Inaugural dissertation on the effusion and organization of coagulable lymph / [George Stewart Newbigging].

Monsieur
Mons. le Professeur Berre

Dup
R.C.S.

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de la part de l'Auteur

INAUGURAL DISSERTATION

ON THE

EFFUSION AND ORGANIZATION

OF

COAGULABLE LYMPH.

SUBMITTED TO

The Medical Faculty of the University of Edinburgh,

IN CONFORMITY WITH THE RULES FOR GRADUATION,

BY AUTHORITY OF

THE VERY REVEREND PRINCIPAL BAIRD,

AND WITH THE SANCTION OF

THE SENATUS ACADEMICUS.

BY

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TO

WILLIAM PULTNEY ALISON, F.R.S.E.,

PRESIDENT OF THE ROYAL COLLEGE OF PHYSICIANS,
PROFESSOR OF THE INSTITUTES OF MEDICINE IN THE
UNIVERSITY OF EDINBURGH,
&c., &c., &c.,

THIS ESSAY

IS RESPECTFULLY DEDICATED,

WITH FEELINGS OF GRATITUDE AND ADMIRATION,

BY HIS FORMER PUPIL

THE AUTHOR.

ON THE

EFFUSION AND ORGANIZATION

OF

COAGULABLE LYMPH.

It has been truly said, that "the human frame carries in its composition and structure the principles of dissolution and decay;"* but it may with no less truth be affirmed, that it contains within it also the materials for repair. These are not, it is true, at all times present in the body, in a condition fit for application, but in healthy constitutions readily obey their proper stimulus; and it is worthy of remark, that this stimulus is but a modification of the same action which in a majority of instances developes the principles of dissolution. This important action has claimed the attention of medical men in all ages; for inflammation is indeed a formidable enemy or useful ally, just in proportion to the command which we are able to exert over its in-

* Thomson on Inflammation.

tensity, and while we dread its presence in many cases, we in probably as numerous a class regret its absence.

It is in what may thus be regarded as its more favourable character that we have now to consider inflammation ;* for next to resolution, its termination in adhesion or granulation must be considered as its most satisfactory result. These may, of course, occur in a locality where their effects may so interfere with the functions of important organs, as to cause great inconvenience, or the death of the individual ; but the aggregate of good gained by the process is probably more than sufficient to counterbalance the amount of evil which it may occasion.

Adhesion and granulation, though correctly described as distinct and different effects of inflammation, may in the following pages be treated of as the same process ; for in both there is the same secretion separated from the constituents of the animal frame. In the one case it forms the immediate bond of union between adjoining parts, or those separated by accident ; and in the other it furnishes a surface in such a condition as to secure its ready union, on their approximation, with any other surface similarly covered. This secretion has been variously named by authors, and the variety of nomenclature has, in all probability, been caused by the different forms which, under certain circum-

* I am aware that it is the opinion of several authors, that adhesion may take place independently of inflammation ; but such is not the view generally taken of the process in these countries, nor is it the one I feel inclined to adopt.

stances and in certain constitutions, it has assumed. Thus we find that, judging from the intensity of symptoms exhibited during life, the same extent of inflammation in a serous membrane will produce in one individual firm bands of adhesion, which in another would only produce a serous effusion, containing flakes of lymph. In the same manner, a wound in one person may heal kindly, and at once; while in another a similar wound cannot be made to unite at all by the first intention. One observer meeting with the first of these cases, would call the matter thrown out organizable; while another, on meeting with cases of the second description, would with equal propriety consider it as inorganizable. The nomenclature suggested by Dr. Thomson seems to be founded on these different modifications; for to that effusion which becomes an organized bond of union he gives the name of organizable, while he calls that inorganizable in which the adhesive process does not take place.* These two forms, however, may be reckoned as but species, comprehended under the generic name of coagulable lymph; and it may still be better, therefore, to retain this last term as expressive of the substance, and subdivide it according to the effects which variety of structure, or of the patient's constitution, may produce in this form of inflammation.

In the following essay allusion will alone be made to that kind of lymph which becomes the seat of organization;

* Thomson on Inflammation, p. 218.

and in its consideration I propose first to notice the process of adhesion or effusion of coagulable lymph ;—secondly, to inquire into the manner in which this becomes organized ;—and thirdly, as a branch of this last division, shortly to consider how far there is any good ground for supposing that blood under any circumstances becomes organized.

I. If the lips of a simple incised wound be brought together soon after its infliction, and kept in apposition, we find that in a very short time they will adhere, and the continuity of the parts be re-established through a living medium or cicatrix, which afterwards more or less resembles the divided tissue ; though it would sometimes appear to be arrested, as it were, in its progress of assimilation, and to continue in a fibrous or fibro-cartilaginous state. This, when no larger vessel is injured, is perhaps the simplest example of adhesion or union by the first intention, and takes place in this way. On the division of the tissue blood is of course poured from the smaller vessels which are divided by the wound, and this may, according to some, become an organized connecting medium. Such, however, being a questionable result, we delay its consideration at present, and proceed to that mode of union which is admitted to occur by all observers. Supposing, then, for the present, that the blood has not formed the connecting medium, it must be separated from the part or gradually absorbed, and as it disappears the divided surfaces by degrees approximate each other, till they are separated only by a

viscid gelatiniform substance, possessing some of the properties of the fibrinous constituent of the blood.

The time necessary for this process has been variously stated by different authors. Dr. Thomson says,* that in some experiments which he made on brute animals, (he does not say what animals these were,) he found a distinct layer of this coagulable lymph covering the wounds he had made, in less than four hours after they had been inflicted. Sir A. Cooper states six hours to be the time which, in dogs, intervenes between the infliction of the wound and the exudation of lymph. This period would seem, however, to be affected by the nature and habits of the animal, which is the subject of our experiment; for in man it is considered, that a somewhat longer interval must elapse, even in favourable circumstances where the constitution is good, and the parts brought soon into contact and excluded from the air, before lymph is poured out upon the surfaces of the wound. Sir C. Bell states, in his Lectures on Surgery in the Edinburgh University, that in about seven hours after the infliction of the wound, the coagulable lymph is effused. But perhaps even a longer period than this will be nearer the true average. Sir A. Cooper† mentions, that in twelve hours the edges of a wound will be firmly glued together; and if we allow a short time to elapse between the effusion of lymph and the agglutination of the parts, about ten hours may be regarded as the period which

* Op. Cit., p. 209.

† Lectures on Surgery, 18mo, 1830, p. 42.

intervenes between the infliction of the wound and the effusion of coagulable lymph. This, however, is, of course, but an approximation to the truth, for in such a question it is almost impossible to arrive at any definite conclusion.

It becomes an interesting object of consideration to enquire how the effusion of coagulable lymph takes place, for, as in the healthy state of the body there is no such product to be met with, so it may seem difficult to determine the seat of its formation on the supervention of inflammatory action. Microscopic observations have thrown little or no light on this subject, and hence we are left to the uncertain guidance of conjecture in attempting to account for the process. Some have held that it exudes from the half closed vessels, while others believe that it issues from the surface of opened cells. Mr. Hunter was led to adopt the latter opinion, because adhesion comes on about the time when surrounding parts begin to swell. Both of these hypotheses seem, however, to be very unsatisfactory, inasmuch as they only account for one modification of a general process. Were the production of lymph never met with, except when surfaces are divided, either of these might be a satisfactory way of explaining the nature of the phenomena ; but, as in many cases, there is no solution of continuity, it seems more philosophical to look for some mode of explanation admitting of more general application.

We should expect to find either a new organ brought into existence for the purpose of depositing this substance, or a new function induced in one with which we are already

acquainted. But while there are no facts to encourage the adoption of the former opinion, there are many to render the latter almost conclusive.

The only conditions required for the performance of the function of secretion, seem to be the minute ramification of capillaries upon the surface of a membrane. The variety in the products of these organs is modified in a manner which, though inexplicable by us in our present state of knowledge, is not the less certain in its operation. Extent of surface, and peculiarity of arrangement may, perhaps, in some measure account for that variety ; but it is evident, that the different organs, where the secretions are separated from the blood, must each be endowed with a peculiar property or susceptibility, whereby, on that fluid circulating through them, one substance is separated in one gland while a totally different matter is separated at another. Whether these products are formed at the glands, or, existing in the blood, are only eliminated at those parts of the body where they appear, is an undecided question in physiology, though many facts, which need not be detailed here, would seem to favour the view of their circulating ready formed.

The effusion of coagulable lymph may be considered as, in many respects, possessing those characters which would class it among the secretions. It takes place, as seems now to be admitted, in the capillaries, and though the membrane on which these ramify, does not present an extended surface, yet this is a condition by no means always present

where other substances, usually termed secretions, are separated from the blood. The capillaries engaged in the elimination of coagulable lymph, ramify in the cellular membrane, and this arrangement cannot be proved to be dissimilar from that observed in other secreting organs. Dr. Thomson* remarks, "that it has been supposed to be poured out from the smaller vessels divided by the solution of continuity; but it seems a more probable opinion, that it is chiefly, if not wholly formed by the secreting action of the capillary vessels of divided surfaces; for even previously, and during the exudation of this coagulable lymph in wounds and ulcers, the capillary vessels in the divided surfaces become remarkably dilated, and seem to pass into that state, which Mr. Hunter has so well described as occurring in adhesive inflammation." The same author adds, "that if the effusion of coagulable lymph ever does take place from the vessels actually divided, it would seem to depend on a change in the action of these vessels, by which they are in some measure converted from circulating into secreting organs." Whether this change takes place or not, though it may be a matter of curiosity, is of no real importance in the inquiry; for if the larger vessels, thus divided, take on a secreting action, they do so only in appearance, and not in reality. They are, in this respect, in the same predicament with large arteries in a state of inflammation, which, while they present all the char-

* Op. Cit., p. 210.

acters of such an affection, are not themselves, strictly speaking, the actual seat of these appearances. The redness, and other symptoms, reside in the vasa vasorum ramifying on the arterial coats, and but for the changed action of the former, the appearances indicative of inflammation would not be observed in the larger vessels. So it is in regard to the effusion of coagulable lymph from the divided vessels. These do not pour it out from their open mouths, neither would they appear to secrete it; but the secretion, if it really does seem to take place from them, is performed by the vasa vasorum ramifying on their coats.

As in healthy blood several of the elements, of what may be termed the normal secretions, can be detected, so it seems very probable, that in the blood of an individual who has been attacked with inflammation, there may also be circulating the coagulable lymph which is to be eliminated at the part more particularly affected. "Inflammation" observes Dr. Alison,* "is in several instances attended with increase and alteration of exhalations and secretions already existing, and always tends to a change of the products formed from the blood at the part which it affects." In organic diseases, accordingly, which in many cases are probably the effects of a peculiar inflammation, the morbid matter which is found deposited in various parts of the body of the individual affected, is also found in the blood. This deposition must have been effected through the medium of the capillary vessels, and may contribute to favour

* Outlines of Pathology, 1st Edition, p. 215.

the opinion, that the coagulable lymph is separated in a similar manner.

The consideration here suggests itself, as to the resemblance which coagulable lymph may be thought to bear to any of the known constituents of the blood. Of these, the fibrin appears to approach to it most nearly in some of its characters ; and the similarity between the two would seem to extend to the causes exciting the development of both. Thus, in blood withdrawn from the body of an individual suffering under an inflammatory attack, the buffy coat is developed on cooling, which resembles the plastic lymph often secreted at the same time so closely, as to lead to the question of how far the former may not be the constitutional symptom, and the latter the local effect of the complaint, while both depend on some peculiar arrangement of the fibrin of the blood. Dr. Alison, in his lectures, mentions a case which, though adduced by him in reference to another subject, is highly interesting as regards the present one. On bleeding a man in both arms, who had incipient inflammation in the wrist of one of them, he perceived the blood issuing from the inflamed limb to be more sizy than that issuing from the sound one. And this is an observation, which, though at first sight apparently inconsistent with one made by Gendrin, will not be found, on consideration, to be at variance with it. The last mentioned author, in his chapter on inflammatory changes of the blood,* remarks, that having bled two men in

* Histoire Anatomique des Inflammations, vol. ii. p. 438.

both arms, who had each inflammation in one of their hands—in the one case caused by whitlow, and in the other by the fingers having been crushed—he found that the blood, whether extracted from the sound or inflamed limb, was buffy; and thence he concludes, that the blood is identical in the veins of both sides, whether the vessels come from the diseased parts or not. This statement does not, it must be evident, in the least affect Dr. Alison's observation; for Gendrin does not mention how long inflammation had been established before venesection was performed, and unless, as in Dr. Alison's case, it was then only commencing, Gendrin's cases cannot be regarded as parallel with that of the former observer. For there is no doubt that, after inflammatory action to any extent has fairly set in, the sizy coat, when present, will be found on the blood from whatever part of the body it has been abstracted.

This analogy between fibrin and coagulable lymph, would seem to be strengthened by numerous observations of different authors, who have satisfactorily established that the proportions of the constituents of the blood in individuals suffering from inflammation of any importance, differs materially from that of those labouring under no such affection. The quantity of fibrin in the former, has been found to be about three times greater than in the latter, or in the proportion of seven and a half to two and a third.*

* See Cyclopædia of Anatomy and Physiology: art. "Morbid Conditions of the Blood."

The frequent occurrence of the buffy coat in blood abstracted from individuals, in whom the action prompting to the effusion of coagulable lymph had set in, affords scope for much curious investigation and hypothesis, though it has as yet engaged little of the attention of inquirers. It seems, however, very doubtful, if any very close analogy exists between these two substances; for if coagulable lymph be a modification of the fibrinous constituent of the blood, it is a modification, as regards its vital properties, to such an extent as nearly to efface its resemblance to the original. Any opinion as to their identity, accordingly, is at best an hypothesis, and quite unsupported by correct information, though it may be admitted that the elaboration which the fibrin may undergo while circulating through the capillaries, might account for a very considerable difference between it and this effusion, even if they were originally the same. Had there been any correct analysis of coagulable lymph, it would have been extremely interesting to have contrasted its constitution with that of the fibrinous part of the blood; but as I am not aware that we possess any satisfactory information on this point, upon which an opinion could be grounded, I am inclined, in the present state of our knowledge, to doubt their identity. Though they may be thought to resemble each other in some of their general characters, yet in their vital properties they appear to be totally different, inasmuch as coagulable lymph is capable of becoming the nidus of new vessels, while the

fibrin of the blood, as will afterwards appear, in all probability does not possess this property, at least after its separation from those vessels which normally contain it.

De Blainville* considers coagulable lymph to be "a pathological fluid," having some analogy with synovia; but it seems probable that more extended observations will ultimately demonstrate it to be a secretion *sui generis*, and though resembling others in some of its external appearances, yet essentially different and distinct in its characteristic properties.

It may be inferred from the preceding remarks:

1. That in the human species, some time, probably about nine or ten hours, elapses after the infliction of a wound, before coagulable lymph is effused; and the same remarks will also apply to its secretion from the capillaries of an inflamed membrane.

2. That this substance is a secretion exhaled by the capillaries; and in no instance is it, strictly speaking, poured out from the divided vessels.

3. That there is no ground for doubting that it is a distinct secretion from the blood, and not analogous to any of the constituents of that fluid, such as they are made known to us in any observations hitherto offered.

II. Coagulable lymph is at first exuded in the form of a clear viscid fluid, which, gradually becoming condensed, assumes nearly the appearance of cellular tissue, in which

* Cours de Physiologie, vol. i. p. 276.

state it forms the cicatrix of the wound. Vessels are observed to ramify in it soon after its effusion, through whose medium a living bond of union is established between the divided surfaces.

The appearance of coagulable lymph at different intervals after its secretion, has been the subject of some experimental observations by Gendrin in his Histoire Anatomique et Pathologique des Inflammations. They were made on all the textures of the body, but those on the cellular tissue and serous membrane, have perhaps the greatest interest as regards the present subject. In the former he made flap wounds in some of the lower animals, and, by examining these at different intervals after their infliction, he ascertained the appearance of the lymph as the reparative process went on. By also modifying the manner of making these flaps, as well as the manner of healing them, he has enabled us to form some conclusion as to the time necessary for organization being established, though this is a point, the difficulty of determining which is attested by the variety in the opinions offered by different authors.

The first series of observations which Gendrin relates, were made upon flaps of skin, illustrating adhesion as taking place in cellular membrane. On the day after raising such a flap and immediately replacing it, the neighbouring cellular tissue on the surface of the body becomes œdematous, and between it and the flap, which is also swollen, there is found a semi-solid reddish substance feebly uniting the two parts together, in the interstices of which at this stage

mercury runs easily. The serous effusion causing the œdema would seem to be absorbed, and the coagulable lymph, increasing and becoming firmer, to cause such condensation of the neighbouring parts, and closing of the mouths of the vessels, as about the fourth day, prevents injection from penetrating either into the lymph or inflamed tissue underneath. The coagulable lymph now assumes a greyish white appearance, becomes more transparent, and blends itself with the reddened cellular tissue, and on the eighth day after the wound, it can be scarcely distinguished from the neighbouring structures. It now presents evident appearances of being completely organised, for on its division, blood flows from the cut surfaces, and points like divided vessels are seen. The result of Gendrin's experiments as to the time required for the organization is rather vague, but in all probability no more definite conclusion could have been arrived at. He states it as his opinion, that there is no precise time when capillaries are sufficiently developed in the tissue of the cicatrix for transmitting the fluids, for he has succeeded in preserving flaps, after cutting off all communication with the wounded parts, except through the medium of the cicatrix, the fifth day after they had been raised and immediately reapplied, while in other cases, gangrene supervened on the section being made even so late as the twelfth day. This apparent discrepancy in his results may be accounted for, if not by idiosyncracy of constitution, yet by the condition of the

animal at the time of the operation. In the hospital we have daily opportunity of seeing the effects of the same operation much varied by the state of the patient's health at the time, and by various other circumstances. Laying, of course, altogether aside the complications which the affections of the mind must create in all operations on the human species, the above remark may apply in such a way as to account for the variety, and it could only be by making the experiment on a very large scale, in exactly similar circumstances that any good average could be made. A project, however, which in its execution would involve greater sacrifice of animal life and suffering than the importance of the subject could warrant: the more especially that we find the time required for the process of reparation in mankind, to be different from that required in the lower animals. For it has been fully established by experiment and otherwise, that repair, and certainly reproduction, goes on more expeditiously and to a greater extent, the lower we descend in the scale of animals.

But even supposing the shortest period specified by Gendrin, namely five days, to be sufficient for the formation of capillaries capable of maintaining a healthy circulation, this is far beyond the time allowed by some authors for the same process in man, whose reparatory powers would seem to be much inferior to those of lower animals. The well known case of hernia, related by Sir Everard Home, would seem, if at all corroborated by other instances, to set

Gendrin's observations and conclusions completely aside. In that case, Sir Everard* states that "the vessels of the gut were minutely injected, the arteries with a red coloured injection, and the veins with a yellow one, and upon examination afterwards, all the adhering portions of coagulable lymph had a considerable artery going to each of them, and a returning vein which was longer than the artery;" and all this in twenty-four hours, for the man died twenty-nine hours after the operation, and Sir Everard Home reckoned that during the last five, no such secretion could have been going on when the pulse at the wrist was scarcely to be felt, and the powers of life were much weakened in every respect. Now, with due submission to so great an authority, some doubt must exist as to the correctness of observation in this case, and that the more, because it stands, so far as I have been able to ascertain, alone in the history of Pathology. There seems reason for thinking that the case has not been reported with sufficient accuracy as regards its details. May it not be supposed, for instance, either that old portions of exuded lymph had perhaps existed in the knuckle of intestine which was reduced, and had not, during the excitement of the operation been observed, or that a neighbouring piece of gut had on some former occasion been studded with coagulable lymph, and having, in consequence of the operation, taken on the inflammatory action, been reckoned along with the

* See his book on Ulcers, 1801, p. 33.

portion actually strangulated. There are many ways, indeed, in which such a mistake might have occurred, and it must at least be admitted, to be more consistent with the great mass of correct observations to suppose that such was the fact, than to subscribe to the accuracy of so anomalous a case. There is also the greater cause for suspecting some inaccuracy of observation or of statement in Sir Everard's case, since we know that Sir A. Cooper and Gendrin have not been able to inject the vessels in cicatrices, till about the eleventh day after the infliction of the wound. There may, no doubt, for aught we know, be something in the coagulable lymph effused in serous membranes which may allow the injection to run in its vessels easier than in those of the cicatrices of wounds, but it is not reasonable to insist that any difference can exist between them to such an extent as to require ten or twelve days in the latter for a full development of vessels, while, in the former, only one day would seem to be necessary for that process. But even in the coagulable lymph effused in serous membranes, a much longer time would seem to be necessary for such complete organization as to admit of its being injected. Thus, Mr. Villermé states* that in his observations on false membranes in man, he never saw vessels distinctly formed in them before the twenty-first day after the attack of inflammation, and at the same time quotes Stoll's opinion, who thought they were well organised

* Dictionnaire des Sciences Médicales, art. Fausse membrane.

by the twelfth day, and never earlier than the eighth or ninth. This discrepancy may, to a certain extent, be accounted for by the difficulty of fixing the exact time of the inflammatory attack; but in whatever way it has occurred, these statements corroborate the accuracy of those authors, who assign a much longer time than Sir E. Home as being necessary for the organization of coagulable lymph, whether in incised wounds or false membranes. But, though it may be much doubted if even the finest injection could have run so early as Sir Everard states, it cannot be denied that the rudiments of vessels could be distinctly seen in the coagulated lymph much earlier, for we have the authority of Sir A. Cooper that such may be the case. "On cutting into adhesive matter," he remarks, "within twenty-four hours after it has been deposited, small bloody spots may be seen which mark the future situation of the vessels which nourish it, but it is not till ten days after it has been formed, that adhesive matter becomes completely organized, for you will find that a fine injection would not enter adhesive matter sooner than the tenth or eleventh day after its formation.* These vessels have been remarked by several authors as extremely thin and delicate, much resembling those of the pia mater; and Lobstein† states this appearance to be so characteristic of them, as also the particular course in which they run, that a piece of newly organized cellular tissue might be distinguished by these features alone. He says

* Lectures on Surgery, 18mo, p. 42.

† Anatomie Pathologique, vol. i. p. 298.

their form and direction are extremely simple; they proceed in a regular course making few turns, and generally in groups like the lymphatic vessels of the limbs.

But though the appearances which the vessels of new formation present, seem now well ascertained by the microscopic investigations of late observers, yet as to the mode in which this organization takes place, different opinions have been entertained. Gendrin has furnished us with many interesting details bearing upon this part of the subject, and his account of the mere process seems to have been accurately drawn up from many highly interesting observations, though I am not inclined to subscribe to his opinion regarding the mode in which new vessels are produced. His chapters on adhesive inflammation, and inflamed textures, especially the serous, furnish us with many examples of the production of a new formative tissue, which ultimately becomes organised and thus constitutes part of the living frame. On the subject of inflamed textures, alluding to the serous, he remarks that when organization begins, the new tissue adheres more closely to the membrane than it did before, and that at those places where adhesion is most intimate, the latter is red and wrinkled, presenting a dotted appearance. It is then covered with small red prominences, in which, with a microscope, red distended capillaries can be seen to terminate, and that at the parts corresponding to them in the false membrane, there are small, red, funnel shaped cavities with their sides roughened as if by laceration, into which these prominences enter. Each of these

small red cavities can be seen with a lens to form the base of from one to three yellowish striae which run upon the adhering surface of that membrane. The vessels when farther advanced in their formation, are seen to be prolonged into the false membrane, and to constitute the rugae above mentioned. He states that in examining the intestine of a guinea pig with a microscope, about the sixth or seventh day after injecting salt and water into the abdomen, small yellowish red streaks can be seen prolonged in the false membrane, which lose their colour as they recede from their origin. At a more advanced stage of organization, vascular filaments can be distinctly seen in the new tissue, which appear to be quite independent of the serous membrane, inasmuch as they look like diminutive isolated trunks which furnish small branches in different directions.

Gendrin concludes from the different experiments which he made on living animals, and from his observations at dissections of dead bodies, that the organised lymph owes its vascularity to blood being propelled by the impulse *a tergo*, from the neighbouring capillaries into the coagulable lymph, where, having hollowed out a passage for itself in the form of an irregular flexuous and unequal streak, the rudiment of a vessel is thus formed. This, if it meet with another like itself, joins it, but if not, continues to prolong itself in the least resisting parts of the new tissue. He conceives that this hollowing out of a passage by the impulse *a tergo* communicated by the heart and arteries, may

be probably quite as well produced in the venous radicles by the peristaltic action of the absorbent capillaries.*

His reasons for coming to this conclusion, as drawn from his examination of the effects of inflammation on the serous membranes, seem to be founded on these asperities or prominences which have been already mentioned as being seen to sprout from the surfaces of the serous membrane into funnel shaped cavities in the effused lymph, which can be seen with the aid of the microscope to form the base of several yellowish and flexuous streaks, running upon the adherent surface of that membrane. These striae would seem to become vascular filaments incapable of carrying the red globules of the blood regularly, though occasionally admitting of their transmission. Uniting with each other, they form small trunks perceptible by the naked eye, through which the red globules pass easily, and the blood flows continuously, and not in jets as in the filaments already mentioned. These small trunks as they are now called, or red capillaries, are in some places elongated without dividing, while in others they branch out into small striae, which become colourless and invisible at the extremities, or anastomose with others similar to themselves, and thus numerous intersections are made of the red by the colourless capillaries. It is thus, if I have fully taken up the spirit of Gendrin's passage on that subject, that he accounts for what

* Op. Cit. Vol. ii. p. 365.

he considers the mistake of those, who think that new vessels in organizable lymph can be formed independently of the circulatory apparatus in isolated points, as in the coat of the vitellus. Mr. Hodgkin, too, considers this view of a "real generation of vessels," as he terms it, to be quite inadmissible, notwithstanding his allowing that "red vessels are first seen in the false membranes without our being able to trace their communication. My own opinion," he adds, "is, that at the inflamed part, the minute vessels not merely become distended, but that their delicate parietes, and the structure through which they ramify, become softened, and yielding by the pressure of the blood in the distended vessels, give way at numerous minute points."* Here too the opinion of Dr. Thomson† may be quoted in reference to the prolongation of vessels from the old into the new tissues. In speaking of the probability of the direct inosculation of the divided extremities of arteries, he observes that he is convinced that "folds of small branches are prolonged into the intermediate space, which become the channels of communication between the larger trunks that had been divided."

In summing up Gendrin's view of the formation of new vessels, it seems to be his opinion that where these capillaries are thus formed, they reunite into small trunks, which may be designated those of reinforcement. It is pro-

* Hodgkin on the Morbid Anatomy of Serous and Mucous Membranes, vol. i. pp. 49, 50.

† Op. Cit. p. 213.

bable that it is the action of these small trunks, which, in producing capillaries directed towards the serous membrane itself, and thus in some measure retrograde, is by a mechanism similar to that which produced themselves, the generating cause of the venous capillaries of which injections in false membranes found in dead bodies prove the existence.* He seems quite convinced from his numerous observations, that lymph is organized by vessels shooting from the inflamed surface, and in his conclusion he is supported by others on whose authority great confidence must be placed. Mr. James Moore of London considers,† that blood-vessels sprout into the lymph from all the inflamed surfaces, and branch through its whole substance; and Sir A. Cooper says, that the new vessels are formed by the elongation of the vasa vasorum of the surrounding arteries which become dilated, lengthened, and serpentine.‡ Mr. Cusack of Dublin, while he does not deny the possibility of vessels being formed in lymph independently of the *vis a tergo*, seems inclined to agree with the above authors in their opinion. In his Lectures on Surgery at the Park Street School, he is in the habit of quoting a case which he considers confirmatory of it, where, in a patient affected with Iritis, he distinctly saw a vessel running from the inflamed Iris into the crystalline lens, and in its course passing through the aqueous humour.

These observations, which would thus account for the

* Op. Cit. Vol. ii. p. 555.

† Dissertation on the Progress of Nature in Healing Wounds, 1789.

‡ Op. Cit. p. 43.

formation of new vessels by a *vis a tergo*, seem to be very unsatisfactory ; for were this impulse of itself sufficient for their generation, the most absurd inferences would follow. Even in the absence of inflammation, the slightest increase of the heart's action might cause this prolongation of newly formed vessels into neighbouring tissues, and thus at no time could any part of our frame be safe from their inroad. If it be said that to cause this, a particular condition of the parts is necessary, we are brought no nearer our object than we were before, because it is just this particular condition which is the object of our inquiry. How far that will ever be ascertained seems extremely doubtful, beyond the simple statement that the coagulable lymph secreted in consequence of inflammation seems to possess the susceptibility of becoming the nidus of new vessels, and that these anastomosing with the vessels of the original tissues, thus establish the secreted lymph as a living part of the animal frame.

While then it seems very doubtful, if vascularity can be established in coagulable lymph by the mere impulse of the heart and arteries causing prolongation of the new vessels from the old, it seems probable that the seat of their formation resides in the lymph itself, as has been the view adopted by many authors, and is moreover supported by the manner in which vessels are formed in the chick in ovo. There we know that a vascular areola is formed around the yolk, before either the heart or arteries could convey blood to it ; and hence we may infer that, though the life and

nourishment of an embryo may be maintained very differently from the mode in which that of the adult is, yet for ought we know to the contrary, an analogous process may take place in each. If, therefore, we have any accurate observations tending to shew the probability of organization taking place in lymph, as it would seem to occur in the incubated egg, such analogy must present an amount of verisimilitude sufficient to throw upon those not admitting such a process the task of proving the contrary. Now, Beclard thinks "that the organisable matter of the agglutination changes into cellular tissue in which there form branched canals which gradually acquire the vascular structure, and which ultimately communicate with the vessels of the inflamed membrane."* He also adds, "On introducing a tube filled with mercury into any part of a recent adhesion at random, branched canals may be injected, the widest parts of which or the trunks, correspond to the centre of adhesion, while the branches running in two opposite directions, like those of the vena portæ, direct themselves to the serous surface, without always reaching those surfaces, and without the latter furnishing very decided villosities." This was also the view taken by John Hunter, who at the same time allowed the vascularity of the new tissue to take place by vessels passing from the inflamed parts.† His observations on this point, as made on the injected intestines

* Elements of General Anatomy, p. 103.

† Hunter on Inflammation, p. 19.

of individuals who had died of peritonitis, are thus given by himself in the following words :—" When vessels of this part are injected, we shall find that in those parts where separation has been made by laceration previous to the injection, the injection will appear on that surface like small spots or drops, which shows that the vessels had at least passed to the very surface of the intestines. In parts where the union was preserved, I have observed the three following facts. On separating the united surfaces in some places, the vessels come to the surface of the intestines, and there terminate all at once. In other places, I could observe the vessels passing from the intestine into the extravasated substance, and there ramifying, so that the vessel was plainly continued from the old into the new. In a vast number of instances, I have observed that in the substance of the extravasation, there were a great number of spots of red blood in it, so that it looked mottled. The same appearance was very observable between the old substance and the new, a good deal like petechial spots." After some remarks on these observations, he concludes that the false membrane or new tissue has the power of making blood-vessels and red blood independent of circulation. Now, these appearances on which this conclusion is grounded, might to a certain extent be accounted for by Gendrin's explanation of their being caused by the smaller white intersecting the larger red capillaries, and thus giving rise to the mottled appearance like " petechial spots," alluded to by Hunter, were it not for the result of the accurate observations made on the for-

mation of vessels in the tunic of the vitellus. These so clearly show that vascularity may be established and maintained in a part, independent of the circulatory powers, as, in our present state of information regarding the process, to challenge our belief in its also occurring in the coagulable lymph.

This is the view also taken by Lobstein,* who considers that new vessels are formed by a vital action inherent in the coagulable lymph, independently of the agency of pre-existing vessels, from which, as admitted by Gendrin himself, it is impossible to inject the former even with mercury. Andral's† authority likewise supports the opinion of isolated vessels being generated in the new tissue before they communicate with those of the neighbouring parts. The same remark may also apply to coagulable lymph which he applies to fibrin, when he observes, "that it may at first be compared to the simplest life of those zoophytes that are composed merely of an amorphous gelatinous mass, and like the lymph, perform the functions of nutrition, secretion, and absorption, although destitute of any vestige of a circulating apparatus." This view is the more tenable when we consider the many corroborations which have of late years been added to the theory of the analogy of structure, of which this observation, if correct, is a beautiful example. The operation of this cause too will be much promoted by a pheno-

* Anatomie Pathologique, vol. i. p. 300.

† Andral's Pathological Anatomy, vol. i. p. 463.

menon observed by Kaltenbrunner* in examining the movement of the blood globules in the transparent tail-fin of a small fish. He remarks, that from their first formation, the globules of blood seem to have a disposition to flow towards the heart to which the canals formed by them are always directed, and when new vessels are developed in the cicatrix of a wound, the newly formed sanguiferous canal, before uniting itself with those which already exist, assumes the form of a crescent, the extremities of which are always turned towards the heart.

Andral further considers, that the first approach to organization is indicated by the formation of red points, such as are observed in the chick in ovo, from which he infers that the "chemical elements of this morbid production have the same tendency as those of the impregnated ovum to form such combinations as shall produce a colouring matter similar to that of the blood." In some cases he says, that a few red points only can be perceived, while in others we can perceive reddish lines or furrows of various lengths running in different directions. They are sometimes isolated from each other, sometimes anastomose. In other instances, he adds, we can observe regular blood-vessels which can be detached from the substance in which they are formed. "As their development proceeds, some of the branches of this independent circulatory system, which,

* See his paper on the circulation of the blood in volume ix. of the Journal des Sciences Médicales, p. 46.

at its commencement, was as perfectly unconnected and isolated as that of the yolk of the membrane in the egg, gradually elongate themselves so as to anastomose with the vessels of the adjacent tissues."* These views he supports by a quotation from a paper by Dr. Dollinger on the circulation of the blood, in the Journal des Progrès des Sciences Médicales, who is inclined to attribute the generation and motion of fluids in the lymph to the agency of electricity. These currents go on, according to this author, in canals which have not the coats of blood-vessels; and this conclusion,† he says, he would have come to, had he never heard of the phenomenon observed in incubation, for his own observations on small fishes, convinced him that these coats were formed piecemeal after the movements of the globules had been observed.

When vessels are formed, and communicate with those bringing on the arterial blood, there is, of course, thus established a regular current from the heart, which must, however, be again returned to the centre of circulation. In the case of false membranes, adhering by only one of their surfaces, it is comparatively easy to understand how the blood, circulating in the newly formed arteries and veins, is returned to the heart, because the apparatus in this case is, comparatively speaking, simple and continuous. In cicatrices of wounds or morbid adhesions, however, the appa-

* Op. Cit. 467-68.

† Journal des Progrès des Sciences Médicales, vol. ix. p. 13.

ratus becomes more complicated in consequence of there now being two connected surfaces. Thus in an incised wound, for instance, it seems very probable that the arteries at first only communicate with the venous capillaries of their own side of the wounds; but as the surfaces approximate each other, the cicatrix becomes denser, and the vessels being thus brought into contact with each other, unite and form a vascular net-work proper to neither surface, for the cicatrix is now assumed as a part of the body itself. There is no good reason for supposing that any of these vessels inosculate with, or join each other by open mouths, because, in the first place, such of them as were opened by the wound, would be plugged up with lymph long ere they could penetrate through the formative tissue; and, in the second place, even if their mouths were not closed, it is by no means probable that they could meet in the cicatrix so exactly as to fit into each other. Gendrin's experiments, too, corroborate the improbability of this inosculation, which was the opinion he himself was led to form on the subject, even though he strenuously supported the organization of the cicatrix by prolongation of vessels by the *vis a tergo*. He found that the vascular ramifications, however irregular they might be in their arrangement, were always prolonged in the tissue of the cicatrix before penetrating the flap, at which, in no case, did they appear to arrive directly, but ran for some length in a line parallel to the incision. Though, without doubt, a perfect anastomosis of the vessels does take place, it is extremely difficult

to offer any explanation of the phenomenon, nor, so far as I am aware, has any satisfactory one been brought forward by authors. It is very probable, however, that the vascular communication between two divided surfaces may be established by their being closely approximated, while as yet the isolated canals developed in the effused lymph have not been endowed with vascular coats, and the globules of blood are still oscillating in them in the manner described by various authors. In the course of this oscillation, the globules proper to one surface may run into the canals formed in the other, till a net-work is thus produced, which, when these vessels are endowed with coats, and the blood begins to flow through them, is so perfect as to be traceable to neither side.

Dollinger describes these globules as in a state of constant antagonism to each other. At one time they may be considered, according to him, as separate pieces of animal organism, and at other times as having a relative existence dependent on their general connection with the sanguiferous system. "It is thus," says he, "that we see them approaching and repelling each other, moving and being moved, separating themselves from the sanguiferous system, and again uniting with it."* These observations, when taken along with the following, by the same author, would seem to favour the theory advanced above. "Sometimes small arterial currents meet each other in coming from op-

* Journal des Progrès des Sciences Médicales, vol. ix. p. 35.

posite sides, and form an anastomosis. From this a new current is established ; the globules of blood from the two sides approach each other in the current, but when the anastomosis presents itself, the globules coming from opposite directions mutually resist each other. I have seen two globules thus meeting mutually arrested, and each balanced by the other, then repel each other, approach and recede. At last one of the two yielding, takes a fixed direction, and returning, is followed by the other." Ramifications will thus be prolonged to either surface, till they join the vessels there, and produce the vascular communication ultimately observed to exist in the new tissue.

Before quitting the subject of vascular development in coagulable lymph, Laennec's description of the organization of false membranes may be referred to. He describes the first appearance of vessels to be irregular lines of greater dimensions than those vessels by which they are to be succeeded. He remarks, that the " blood seems as if it had been forced into the substance of the false membrane by a strong injection, and we find the corresponding portions of pleura redder than elsewhere, and, as it were, spotted with blood. After a time, the pseudo-membranous layers become thinner and less opaque, the lines of blood assume a cylindrical shape, and ramify in the manner of blood vessels, but still observing their augmented diameter. On minutely examining these at this stage, we find their external coat consisting of blood scarcely yet concrete and very red ; within this, there is a sort of mould or rounded sub-

stance, whitish and fibrinous, and formed evidently of concreted fibrin perforated in its centre, already permeable to the blood, and evidently containing it. Eventually, these vessels exactly resemble those which ramify on the inner surface of the pleura."*

These observations perhaps do not exactly bear upon the question, as to whether the new vessels are formed by the direct impulse of the blood from the heart and arteries, or by being first moulded in effused lymph, and then receiving from the arteries the blood which entitles them to rank as part of the vascular system. If correct, they at least throw some light on the structural anatomy of these vessels, which cannot but be interesting. Laennec seems however to support the theory of these lines of blood being formed by the impulse *a tergo*, but on the supposition of his taking the other view, though he describes their structure, he gives us no clue by which we can ascertain the mode of their generation.

Sir Everard Home who considered that extravasated blood could become organised, offers an explanation of this process, which, though not very tenable, may here be mentioned. In his Croonian lecture read to the Royal Society in June 1817, on the changes which blood undergoes during its coagulation, he gives an account of some experiments which he made along with Mr. Brande, in order to ascertain the manner in which coagulable lymph or extravasated

* On Diseases of the Chest—Translated by Forbes, p. 398.

blood was permeated by vessels and became a living solid. In these he was directed by an observation made a short time previously by M. Bauer in regard to the prolongation of the tubular hair in germinating wheat. M. Bauer remarked, that in the earliest stage of the vegetation of that grain, a kind of slimy pustule accumulates on the surface of the young root, through which a bubble of air bursts, (ascertained to be carbonic acid gas), and then blows, as it were, a tube, of which this slimy substance forms the walls. With this before him, Sir Everard set about to establish the likelihood of a similar process taking place in the animal economy. The conclusion to which he came from his experiments on this subject was, "that blood in coagulating gives out much carbonic acid gas, which in the course of its extrication forms a network anastomosing with itself on every side, through every part of the coagulum." In this way, he says, there is no difficulty in accounting for the manner in which blood extravasated in living bodies afterwards becomes vascular, "since all that is necessary for that purpose is red blood being received into the channels of which this net-work is formed."*

This is indeed a beautiful theory, and its simplicity and elegance are such as to make one wish it were a sound one. It is, however, by no means ascertained that extravasated blood ever becomes organised, and even if it were, I doubt much if this could explain the rationale of the process in

* Philosophical Transactions, 1818, p. 182.

such a nidus, at all better than it does with regard to coagulable lymph. That carbonic acid gas is given off during the coagulation of blood is now very well ascertained, and, though not so well established, it may be admitted to form such cavities or canals in the coagulum as are described by Sir Everard Home; but it remains yet to be proved that such can take place in the lymph secreted in the living body. It is not easy to see how this can be determined either in one way or the other by experiment made during life; and as it would appear that these phenomena are by no means the property of organic fluids alone, they cannot be fairly held as accounting for the vital process of the formation of new vessels.

But even supposing that such were the appearances discernible during life, it cannot be shewn that they would help us at all to an explanation on this subject. The question still remains as to the manner in which blood circulates through a false membrane, and it cannot be expected that canals thus mechanically formed can be fit instruments for circulation or secretion. We must at last call in the aid of a vital action to give them this property or power, and it would be better and simpler to ascribe to this at once the whole agency.

The results of the preceding observations would seem to be,—

1. That soon after the secretion of coagulable lymph, perhaps even in a few hours, blood vessels begin to form in it, but that no vessels capable of carrying injection can be

detected for several days, at least five, after the commencement of inflammation.

2. That the seat of the formation of those new vessels is in the coagulable lymph, which is endowed with this vital property or susceptibility : and that these new vessels are not referable to any mechanical origin.

3. That in these new vessels, blood is formed independently of that coming from the heart and arteries.

4. That the action of the heart and arteries, or the *vis a tergo*, has little or no effect in the production of new vessels, but can only act in establishing the connexion between these and the vessels of the original texture.

III. Physiologists have entertained very different opinions on the question as to whether or not blood can in any circumstances become organized. It is a subject still fraught with much difficulty, for while arguments are not wanting in favour of its being the seat of organization in some cases, there would appear to be sufficient evidence that in others it does not possess such a property. Without being at all inclined to deny the vitality of the blood, I think it is extremely doubtful if blood ever becomes organized when once separated from those vessels which normally contain it.

Mr. Hunter, however, and after him Sir Everard Home, were in favour of such a process taking place in blood in such a condition ; and the opinion of the latter regarding the manner in which the vessels were formed, has been al-

ready alluded to. It is to be feared that he has been precipitate in rearing up an hypothesis to account for a phenomenon whose existence he ought first to have properly established; for though many circumstances might lead to the inference that blood may become organized while contained in its vessels, no convincing observations have, so far as I am aware, been adduced in favour of such a process occurring in blood which has been extravasated. Mr. Hunter has throughout his writings explicitly stated his belief that the blood can in this state become the nidus of vessels, but one would almost be inclined to think that in his work on the blood, he had somehow taken up the impression that it had such a property, and perhaps never applied his powerful mind to the subject so closely and dispassionately as to be undeceived.

In all the instances adduced by him, the organization can at best be only said to have taken place in situations where blood had been previously effused, for it cannot be said positively that it took place in the blood itself. Though it may be admitted that vessels existed in the substance formed where blood had been extravasated, it seems extremely doubtful whether this nidus was the residue of the blood itself, or a new secretion which the former, acting as a foreign body, had excited the neighbouring capillaries to give out. Blood may indeed assist in keeping divided surfaces together for some time after a wound has been inflicted, but this would seem to be merely the agglutinating effect of its albumen, and not the living bond which is to

form the cicatrix. Were coagulable lymph not effused, this agglutination by blood would in a short time be broken up, and granulation from the bottom of the wound take place in order to restore the continuity of the surface. As coagulable lymph is secreted, however, the blood is absorbed, and the former becomes the seat of vascular ramification. That this tissue was the residue of the effused blood, would seem at first sight to be proved by several morbid appearances, of which those occurring in the brains of individuals who have died after apoplectic attacks are perhaps the most striking. If the brain of one who has died a few days after such an attack, be examined, the effused blood will be found in a fluid state; if after the lapse of a few weeks, the blood will still be found there, but enclosed in a cyst or sac; and if the brain be examined a considerable time subsequent to this, when the patient has recovered from the first attack, but has died of a fresh one, or some other disease, nothing can be seen but a nucleus of coagulable lymph, from which the more liquid parts appear to have been gradually absorbed.

These appearances might seem to support the opinion of the fibrin of the effused blood ultimately becoming organized, were it not for the observations which practical surgeons constantly have an opportunity of making on the decided interference which the effused blood presents to the union of wounds. They find that the more completely a wound can be cleared from such superfluity, the surer are they of obtaining a favourable result in union by the first

intention, and that in all cases the blood would seem to act only as a foreign body. This seems to be its effect in these apoplectic cysts to which allusion has been made. Its presence there, acting as a foreign body, sets up, by its irritation the adhesive inflammation around it, and coagulable lymph being poured out, forms a cyst just in the same manner as we find a bullet enveloped in other parts of the body. The blood is afterwards gradually absorbed, and thus when examined some months after the attack, the brain presents no appearance but this patch of lymph.

If blood could be extravasated without losing its vitality, there might be some grounds for admitting the probability of the organization of its clots. Observation, however, while it renders this extremely doubtful, favours the view that its being contained within its vessels, is one of the conditions necessary for the maintenance of its life; and as effusion from these would thus imply its death, that must be a state incompatible with any living process such as organization. Mr. Hunter thought that the coagulation of blood was the last exertion of the vital properties of the fibrin, and was analogous to the stiffening of the muscles after death. The analogy fails, however, in one important feature, because the stiffening of the muscles goes off in some time after death, but the buffy coat of blood withdrawn from the body is not so affected, but continues concrete. I need not at present enter more fully on this subject, as it seems now the more generally received opinion, that the coagulation of blood, when withdrawn from the body, may be regarded as

the effect of its loss of vitality; and this remark may be carried still farther, because there seems ground for believing that, even when extravasated within the body, the blood is also in that case deprived of its vitality. Against this statement there may be urged the case of hydrocele, which is furnished to us by Mr. Hunter, where the coagulum of blood found upon the body of the testicle a month after the tunica vaginalis had been tapped, appeared to have been injected. Here, however, some mistake in observation may very reasonably be inferred, because Mr. Hunter himself tells us that "the surface of adhesion of the larger coagulum was injected for only about one-twentieth of an inch, and that the smaller one was in many places injected through and through, and in others only for a little way along the surface of the adhesion."* May it not be supposed that the phenomena described, if not occasioned by adhesive inflammation caused by the puncture of the lancet, may be explained by reference to what has been already said as to coagula of blood acting the part of foreign bodies, and thus setting up inflammatory action in their neighbourhood, which in its turn again prompts to the effusion of coagulable lymph.† This effusion seems in the

* Hunter on Inflammation, &c. p. 571.

† Since the above was written, I have been informed by Dr. Alison, that Mr. Clift, the Conservator of the Museum of the College of Surgeons of London, after a careful examination of the preparation alluded to, has come to the conclusion that the substance injected on the body of the testicle was not the coagulum of blood, but lymph subsequently effused.

case of the larger coagulum to have been so thin as one-twentieth of an inch, and in the smaller one may be assumed as having been in some places even thinner, and thus accounting for its being partially injected "through and through." Here, too, Mr. Hunter, in his anxiety to prove the organization of the clot of blood, seems to have gone too far, and entirely forgotten his own opinion as to the mode of formation of the new vessels. For if it really were the coagulum of blood which had become organized, should we not, according to his views, have had more of it injected, because vascularity is established, "not only by the impulse of blood *a tergo*, but also by the formation of vessels which the coagulum has the power to form in and of itself;" and a month should have been sufficient time to admit of a connection being opened between these isolated vessels and those of the testicle. The same remarks will of course apply to another case of supposed organized clot of blood in the uterus, also mentioned by Mr. Hunter along with the preceding.

On the whole, then, it may not be regarded as over-scrupulous scepticism, if these cases be not held as at all satisfactorily establishing a phenomenon which we have positive proofs does not take place in an overwhelming majority of cases. In such a question as this, no doubt one well authenticated case would amount to a positive proof of the possibility of the occurrence, rare though it might be, but the cases where it has been alleged to have taken place are so solitary, and so unsatisfactorily proven, (if indeed

they can be said to be proven at all), that in our present state of information, till further corroborative observations on the subject be furnished, such a process cannot reasonably be held to occur.

There are, however, some cases in morbid anatomy which would serve to strengthen the probability of blood becoming organized when it is not effused from its containing vessels. The coagula in different blood vessels are adduced as instances, though even in them it is often doubtful whether the matrix of the new vessels is the original clot or the plastic lymph effused in consequence of their presence. Of such formation we shall now only notice those concretions termed phlebolites, which are sometimes developed in the veins, and have been described by different authors; as also such bodies occurring in the cavities of the heart as have been proved by injection or correct observation to be the seat of vascular ramification.

With regard to the formation of phlebolites various opinions have heen advanced, on the respective soundness of which depends, in a great measure, the alternative, whether these bodies can or cannot be regarded as assisting in the proof of the organization of blood. Andral considers that cretaceous matter is first formed behind the lining membrane of the veins, which is gradually protruded into their caliber, and may there either be suspended by a peduncle, or, in consequence of this giving way, may drop

loose into the vessels.* The opinion of those authors, however, seems to be the more correct, who think that phlebolites are formed from the blood; and the delineations given by Dr. Carswell† shew that a coagulum is first formed in the vein, in whose centre a small nucleus is gradually developed in concentric layers, and after a certain time, the colouring matter having disappeared by absorption, the body is then found to consist entirely of fibrin. The change from this state would seem to take place in layers, till the whole body become, in a manner, ossified.

Such is also the result of my friend Dr. J. Reid's observations on the subject,‡ who tells me that he has seen phlebolites in many different stages of their progress; and from what he has remarked, it would appear that Andral's statements are founded on observations made only upon those bodies in their mature state. Dr. Reid has seen them as coagula of blood and of fibrin, arranged in concentric layers, varying in density from the centre to the circumference, with no calcareous deposit within them at all. Others he has examined which contained in their centre a very small quantity of gritty matter, while some were altogether a cretaceous mass. It is not easy to understand how these coagula of blood could remain unat-

* Pathological Anatomy, vol. ii. p. 423.

† See his Eleventh Fasciculus of Pathological Anatomy.

‡ See some excellent observations by this gentleman in the Edinburgh Medical and Surgical Journal, No. 122 and 123.

tached to the sides of the vessels without being carried forward in the course of the circulation to the heart, though such stagnation may, to a certain extent, be accounted for by the fact, that most, indeed I believe all the cases of such bodies being generated, have occurred in parts whose dependent situation or other anatomical relations impeded the free flow of blood through the veins. Laennec quotes many examples of organised coagula occurring in veins and arteries in other situations, but these were united to the coats of the vessels by one or more attachments.

At some period of the formation of all such bodies, whether phlebolites or others, it seems probable that there must have existed some attachment to the sides of the vessels, probably in consequence of the local irritation which they must there have excited; for without such living connection it is difficult to conceive that they could have progressed to the state in which we find them. In confirmation of this, Laennec remarks,* "that the more recent concretions are not adherent, but only those which are proved by their firmness and comparative dryness, and otherwise changed condition, (and also sometimes by the contraction of the vein,) to be of ancient formation." Dr. Reid, however, who, as I have said, has seen phlebolites in all their stages, has remarked that he never found any attached to the sides of the vessels, nor could he, in those which he examined, discover any appearance to justify him in considering that they had ever been so united. Though

* Op. Cit. p. 608.

much doubt must still exist as to the manner of their formation, the phenomenon cannot be regarded as unimportant in relation to the present question. It does not seem probable that they will be found to be the product of mere mechanical deposition of calcareous matter ; and I am rather inclined to adopt the opinion of Dr. Reid, speculative though it may at first appear, that " they are the result of a process resembling the formation of osseous tissue in the other parts of the body ;"* and if the mode of their formation may be thus explained, they may constitute an important argument in favour of the possibility of blood becoming organized while contained within its vessels. The theory of those who would attribute their formation to the mere separation and mechanical conglomeration of the earthy salts moving in the blood, seems scarcely tenable ; for all authors who have examined them, concur in the description of the calcareous layers extending from the centre outwards ; and this could not be the appearance presented, unless their formation took place by interstitial deposition, which is the characteristic mode of increase in all organised substances. Jules Cloquet† gives delineations of two, in one of which there

* Their chemical analysis, as given by Gmelin and verified by the report of Mr. Kemp of this city to Dr. Reid, shews that their constituents are similar to those of bone.

† Pathologie Chirurgicale. Pl. iii. I have lately examined several of those bodies which I found in the uterine veins of a woman of about 40 years of age, and found them to correspond very closely with the delineations given by Cloquet.

was a bony nucleus in the centre, enveloped by fibrinous layers, and in another the nucleus consisted of " whitish fibrin ;" the description of which appearances would certainly favour the opinion of the calcareous matter being secreted in the coagulum, and not mechanically deposited by the blood in its circulation.

It may be thought by some, that I should have here adverted to the coagula formed some way up in the arteries, which have been torn by accident, or enclosed in ligature ; but, as in these cases the fibrinous clots or plugs seem evidently the produce of the exudation of coagulable lymph, caused by the adhesive stage of inflammation, they cannot be considered as bearing on the present part of the subject. In all cases, indeed, of blood becoming organized, its colouring matter is generally absorbed before the formation of vessels, and thus, strictly speaking, it is the fibrin which becomes the tissue in which the new vessels ramify ; but then, in arteries which have been tied or ruptured, the plastic lymph effused in consequence of inflammation is the original coagulum, whereas, in the former cases, it is probably the residue of a clot of blood.

Those polypous bodies which, under various forms, are sometimes found in the heart, may also favour the probability of blood becoming organized while contained within its vessels, though the doubt which seems to be connected with their original formation, must make us careful in admitting them as positive proofs. It is unnecessary here to take any notice of false polypi, as they have been called,

which occur in the heart and arteries after death, inasmuch as they seem to be formed in the same way as the buffy coat is formed in blood which has been abstracted from the body. They seem to be the concreting of the fibrin which takes place either after death, or immediately before it when the circulation is extremely languid. They are found generally of a homogeneous yellowish appearance, without the least symptom of vessels having been formed in them, if we except the bloody discoloration which, however, is clearly the effect of the entanglement of the red globules in the meshes of the fibrin during its contraction.

But there are many instances of abnormal formations taking place within the heart during life, which certainly appear to become organized, though the mode in which this process takes place be not yet ascertained. If we adopt Laennec's* view, those vegetations or warty excrescences formed at the base and free margin of the valves, are mere modifications of organized polypi, and would therefore, as well as the latter, require to be noticed here. Dr. Hope's† opinion would seem, however, to be more correct, in considering these two productions to be differently caused, inasmuch as amongst other valid reasons, the vegetations seem to be attended with apparent lesion or disease of the internal membrane, while polypi are found to exist without any such appearance. The former cannot accordingly be considered as favouring the theory of the organization of

* Op. Cit. p. 612.

† Hope on Diseases of the Heart, 1832, p. 320.

blood, because their existence would appear to be caused by "inflammation modified by some other morbid cause;"* and hence it is more probable, or at least equally so, that they are formed from the plastic lymph effused by the adhesive inflammation in the lining membrane, than that blood was the original nucleus. These coagula, according to Hope, by irritating the lining membrane of the heart, effect their adhesion to its walls by the lymph exuded by the latter. It will be better, therefore, not to enter on the very debateable ground of the formation of these vegetations, but rather trust solely to such instances of organized clots as have been by the generality of authors supposed to commence independently of any morbid state of the containing vessels or cavities.

Organized polypi are considered by some to owe their formation to inflammatory action; but by others the opinion is held that they are produced without any such cause. The latter is the conclusion arrived at by Laennec, Hope, and others. They attribute their formation to "retardation, and consequent stagnation of blood;" and Dr. Hope† thinks that the adhesion to the walls of the heart is caused by the "irritating action of the body itself, whence there results an exudation of lymph which forms the agglutinating medium." It would seem that in going thus far, he invalidates the probability of the non-inflammatory origin of these bodies, because the action which he

* Hope on Diseases of the Heart, 1832, p. 323.

† Ib. p. 509.

now calls in for their adhesion, is such as would have singly occasioned a similar production. This being the case, before allowing that they can be formed by simple retardation, some positive proofs must be adduced of their formation in that manner, since we have so many instances of inflammation causing similar phenomena.

That these bodies, however, are not the product of the effusion of coagulable lymph, but can be formed in the absence of inflammation, is rendered probable from the consideration that we frequently find in the heart and larger vessels immediately after death, fibrinous masses of such consistency as strongly to favour the opinion of their having been formed during the life of the individual,—that these bodies are unattached to the walls of the containing cavities, and in many cases no appearance can be discovered on their surface, such as can induce us to infer that they had ever been so attached,—and that the lining membrane of the heart or vessels in such cases presents no traces of the previous existence of inflammatory action. When polypi have thus been formed, a question arises whether their organization takes place solely within themselves, or whether a connecting medium is first established with the walls of the heart. The remarks already made on phlebolites will be equally applicable here, for in both cases though the observations of some authors would lead us to think that organization must go on before there is any attachment, yet those of others are equally in favour of such being necessary. The latter view appears in some measure to be supported by an observation

of Laennec on what he terms "globular excrescences," which Dr. Hope considers identical with polypi. He remarks that the peduncle attaching them to the walls of the heart, "seems as if it were of more recent formation and less perfectly organised than the body itself;" and if such be the fact, it may be inferred that organization may have been progressing to a certain degree in the excrescence before its adhesion to the walls of the cavity. It seems highly probable that here, as in the organization of the coagulable lymph effused in inflammation, the opinion of both parties may to a certain extent be equally sound. The fibrin of the blood thus coagulated within its vessels, may still have the power ascribed to it by Mr. Hunter, of "making blood vessels and red blood independent of circulation;" though that circulation of the fluids necessary for continuing the vitality of the clot may not take place till it be connected with the walls of the heart. Vessels may accordingly be developed in the new tissue of the polypus, even before it becomes united to the walls of the heart, and afterwards through the medium of the peduncle, those from that organ may be prolonged, and circulation* be thus established.

Whatever the process may be, we do not want examples† of such organised polypi, while there seems reason for believing that clots of blood have originally furnished the

* See Bouilland, Traite Clinique des Maladies du Cœur, vol. ii. p. 609.

† Ib. p. 606. Hope and Laennec as quoted; also Burrow's Lectures on the Blood, vol. xvi. Medical Gazette.

nidus without the presence of inflammation, though that action would also seem in many cases to favour the progress of their organization.*

Amid the many conflicting statements regarding the capability of blood becoming the formative tissue of new vessels, nerves, and lymphatics, it is very difficult to form any decided opinion. The conclusions, however, which would seem to follow from what has been stated, are,

1. That it is extremely doubtful if in any case the process of organization can take place in blood which has been extravasated.

2. That facts are not wanting which seem to support the probability, that while still within these cavities which normally contain it, blood may coagulate during life, and become the basis of an organized tissue. Whether this can take place, however, independently of inflammatory action, is a point of much difficulty to determine, though some observations appear to favour the probability that it may.

The organization of coagulable lymph and blood has thus far been considered, only as regards the ramification of blood-vessels, and no mention has been made of the other characteristics of the phenomenon, viz.—the development

* Other evidence might have been adduced of the probability of organization taking place in these bodies, such as the appearance of purulent collections in the fibrinous cogula found in the cavities of the heart, &c. I regret however that time will not at present permit me to enter on such considerations.

of nerves and lymphatics in the formative tissue. The appearance of these, however, need not occupy a prominent part in this paper, on account of the observations already offered on vascular formation. If in the latter case, it would appear that vessels are formed in the new tissue independently of any influence of the heart, by a vital process of whose nature we are ignorant, it may with equal fairness be concluded that nerves are developed in a similar manner. Observations too, which have been amply verified, go to prove, that where portions of nerves in living animals have been injured or removed, a substance is formed to repair the lesion, which sooner or later assumes their true vital properties.* Thus then, as it would appear that nervous substance can be reproduced in the living body when arrived at maturity, and as in fœtal development its formation is independent of its centre, so its generation in the new formative tissue would seem to be in the same predicament with the development of new vessels, and thus render further notice unnecessary.

The same remarks may be applied to lymphatics, for though in regard to their formation we have less correct information than in regard to blood vessels and nerves, yet there is good reason for concluding that their development in the new tissue takes place by a process similar to the others.

* See Dr. Alison's Outlines of Physiology, p. 139.