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ON THE ORGANISATION OF THE THROMBUS FORMED IN AN ARTERY AFTER LIGATURE.

Read in the Section of Pathology at the Annual Meeting of the British Medical Association held in Dublin, August, 1887.

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THIS study is based on the macroscopical and microscopical examinations of a series of sections of arteries prepared by the author for Mr. C. T. Dent, F.R.C.S., Assistant Surgeon to St. George's Hospital. These arteries had been tied in Australia (on account of prohibitive laws) by Mr. E. C. Stirling. Although Mr. Dent has not published the results of his observations on the properties of ligatures used in these cases, he has very kindly allowed the publication of some of the observations which have been made by the author on the organisation of the thrombus. The animals used for these experiments were adult sheep, and the artery tied in all cases was the femoral.

The effects of age, sex, state of the individual, or the influence of the species or of disease are therefore not considered.

The following views are supported or advanced in the communication, and are demonstrated by means of a number of microscopical sections of arteries removed from the body, 5, 9, 13, 17, 20, and 23 days after ligature:—

1. The coagulation, although nearly always present, apparently is not a necessary phenomenon. The presence of a ligature and the obliteration of the vessel are not in themselves sufficient to cause thrombosis, for, if the artery be tied immediately below a collateral branch sufficiently large, the clot may be almost or even entirely absent. The size of the coagulum depends on the distance existing between the ligature and the first collateral branch above. Coagulation may occasionally occur in the portion of the artery which is beyond the ligature (in relation to the heart).

2. The clot which is observed in an artery a few days after ligature is not simple; it is composed of a variable number of smaller clots, more or less recent. The oldest are those nearest to the ligature and most central; the most recent are, on the contrary, those which are most proximal. In addition, as after coagulation has taken place the clots contract, new coagula become deposited in the spaces formed between the original coagula and the walls of the artery. As these clots contract they carry away with them some of the cells of the intima which are attached to their surface. They may even by their contraction cause a separation between the superficial and deep layers of the intima, causing thus the formation of more or less oblique fissures into which the blood, coming from the still patent portions of the vessel, may rush.

3. The cells of the tunica intima are the chief factors in the so-called organisation of the thrombus, and this accords with the views supported by Cornil and Ranvier, but the most active parts are not, as they say, in the immediate neighbourhood of the ligature. The proliferation of the cells of the intima is most marked at the level of the proximal convex surface of the clot, that is, at a distance from the ligature equal to the length of the thrombus. It is at that level that the new connective tissue, formed at the expense of the intima, penetrates most deeply into the substance of the clot.

4. The leucocytes, or small round cells which are found in the clot, either because they were in the blood before coagulation or have penetrated from outside the vessel into the coagulum by diapedesis through the arterial walls, do not seem to play an active part in the organisa-

tion of the coagulum. They have a tendency to accumulate near the surface of the clot.

5. The so-called vascularization of the thrombus corresponds to three processes which follow each other, but are based on different properties.

The first of these processes does not give rise to a true vascularisation, whilst the second produces only a preliminary arrangement during which there is no true circulation.

(a.) The first, or false vascularisation, is simply due to contraction of the clot; it is a kind of mechanical vacuolation. It is the only kind of canalisation that exists during the first decade, and probably it can still produce some effects after that time.

(b.) The second or potential vascularisation, is due to the arrangement of cells of the tunica intima which form the connective tissue invading the clot. This arrangement of cells gives under the microscope the appearance of a vascular network, but there is as yet no true circulation. This state may exist up to the twentieth day, or even later.

(c.) The third or true and effective vascularisation, begins when the embryonic vessels, which have just been mentioned, become hollow, and circulation becomes at last possible through the plug of young connective tissue which has taken the place of the clot.

The embryonic vessels at this stage pass through the tunica media (which has degenerated through disuse) and anastomose with the vessels of the adventitia, of which many are of new formation, in the neighbourhood of the ligature. Blood can therefore now pass from the patent part of the artery into the surrounding tissues through these small channels. Judging by our specimens this does not take place before the twenty-third day, but it is possible that in other cases this may take place either sooner or later.

6. *Conclusions.*—The essential factor in the organisation (or rather the replacement) of the clot is therefore the tunica intima. The clot itself is nothing more than a complication which probably is useful, but which finally entirely disappears, being replaced by the connective tissue resulting from the proliferation of the cellular elements of the tunica intima.

The internal coat is always altered whether there be thrombosis or not, but when there is a coagulum the proliferation is most marked in the region of the proximal surface of that coagulum. The presence of the clot seems to give a greater intensity to these phenomena, as can be seen by comparing the walls of the vessel on the proximal and distal side of the artery and in the cases where thrombosis is apparently absent and those where it is evidently present.

The channels which are found in the clot during the first two weeks are not true vessels, but simply fissures—vacuoles—due to contraction of the coagulum. There does not seem to exist any true circulation in the tissue taking the place of the clot before the end of the third week, at least as far as one can judge from the small number of cases examined.

These views are all based on direct observation, and partly support the views of several observers, such as Stilling, Cornil and Ranvier, Schultz, Riedel, Durante, Hamilton, Ziegler, Ballance and Edmunds, etc., but a critical examination will easily prove that, taken as a whole, these observations present some novel features. On the other hand, they are antagonistic to the views advanced by a great number of writers. Their publication is therefore justified in the mind of the author.

(The arteries were tied in September, 1884, by Mr. Stirling. Microscopical preparations were made in the winter 1885-86. A great part of the report was already written in March, 1886, and therefore this inquiry was conducted at the same time as that of Messrs. Ballance and Edmunds, and is to be considered as a parallel investigation perfectly uninfluenced by their work.)





