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Spence, James, 1812-1882.
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Publication/Creation

[Edinburgh] : [Balfour and Jack, Printers], [1843]

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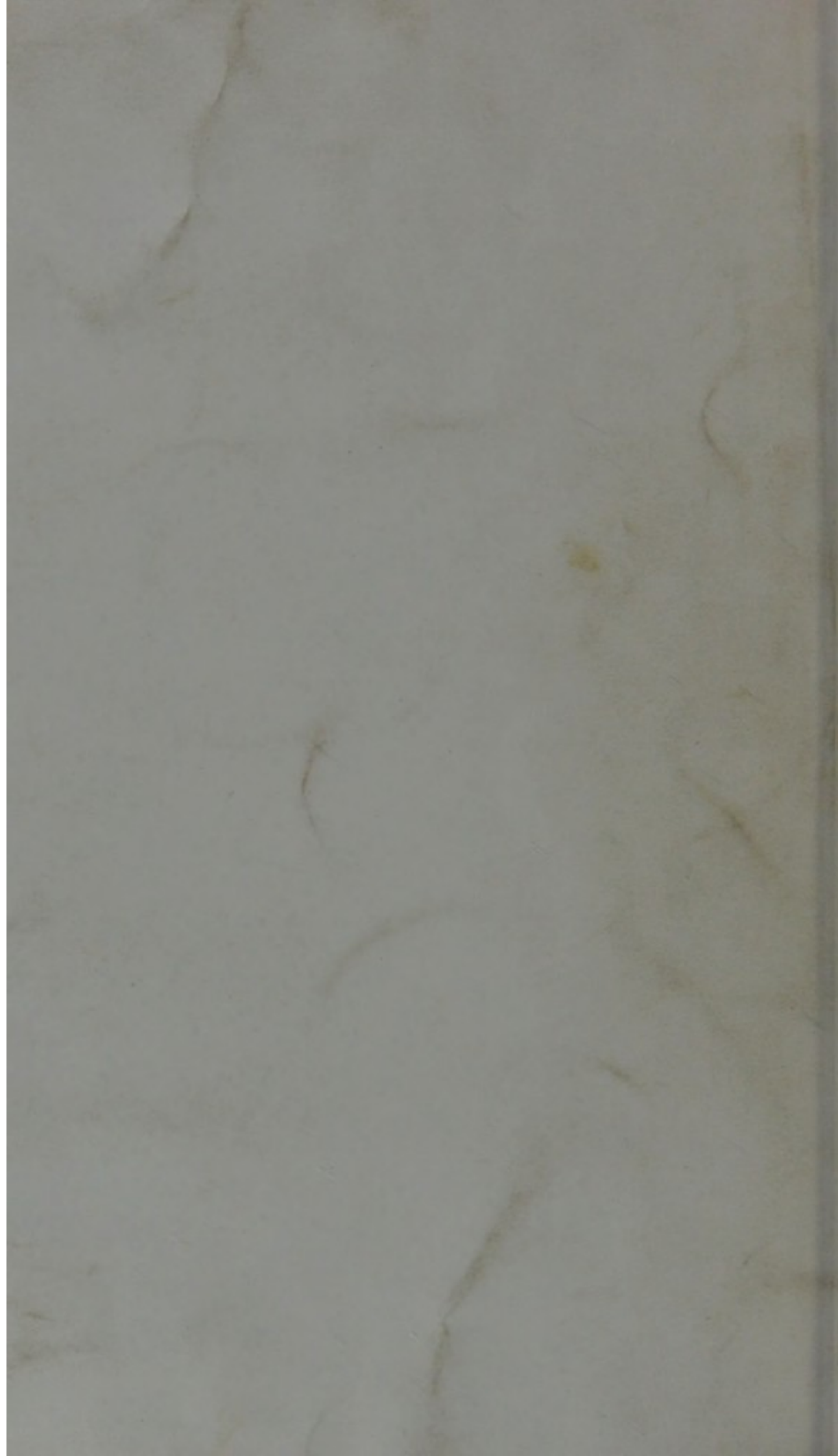
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Remarks on some points connected with the Ligature of Arteries.
By JAMES SPENCE, Esq., Surgeon, one of the Teachers in the School
of Anatomy, No. 1 Surgeon Square, Edinburgh, Lecturer on
Operative Surgery, &c.

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(Extracted from the Lond. and Edin. Monthly Journ. for June 1843.)  
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The following remarks are the results of a series of experiments on the ligature of arteries, which induce me to believe, that whilst very great attention has been paid to the investigation of some of the causes of the obliteration after ligature, and great importance attached to certain parts of the process, there is one, which, although it must have been noticed by all, and is alluded to by some who have investigated this subject, has never received what I believe to be its due share of importance.

In attempting to establish this proposition, it will be necessary to examine what are the present opinions as to the changes essential to the obliteration of an artery after ligature, and whether these opinions are satisfactory; this I shall do as briefly as possible. The writers who hold different opinions on the subject may be divided into three classes.

The first class believe that permanent closure of an artery is principally effected by adhesion between the surfaces of its internal coats, but that the clot is necessary up to a certain stage of the process, viz., until, by its presence, it shall have excited such a degree of irritation as to give rise to adhesive inflammation between the opposite surfaces of the internal tunics of the vessel, to a greater extent than the presence of the ligature alone could produce; and then, having no farther need of its services, they dismiss it somewhat unceremoniously. I shall give the views of the late Mr Allan Burns in support of this doctrine, as embodying most fully the opinions held by this class.

“There is a part of the process of obliteration which must be attended to; I mean the clot of blood which is sometimes formed in the vessel. If we view this in its proper light, we shall have occasion to admire the office it performs. Bichat has shown, that naturally no absorption goes on from the inner surface of arteries. Nature has, therefore, increased her own task, by forming a bloody clot. Unless it performs a part in the process, its presence must be detrimental, since it must be removed before adhesion can take place. Where it is found, such a change must afterwards be induced, in the nature of the internal coat, as shall adapt it for removing, by absorption, the extraneous substance. The accomplishment of this also renders the aptitude for adhesion greater.

“A coagulum, as we learn from Dr Jones’ experiments, is

chiefly formed where the distance from the ligature to the first lateral branch is considerable. Where the distance is short, the ligature excites a sufficient degree of irritation to produce the lymphatic effusion, but, where it is considerable, that part in the vicinity of the thread is sufficiently excited; not so the more remote part. From the natural effect of the stagnation of the blood a coagulum is formed, which, being an extraneous substance, excites the action of that part of the canal of the vessel with which it is in contact, procures its own absorption, and, at the same time, causes an effusion of organized lymph. This is really the only benefit which can be derived from the formation of a coagulum; and its presence, under these circumstances, shows that all that is required to produce obliteration is a certain degree of irritation applied to a healthy artery. If this be brought about, the adhesion will be complete."

Now, let us see how far this very plausible theory can stand the test of examination, or is consistent with known facts. *First*, as to the use assigned to the clot. Do we find that the thin coagulum effused between the surfaces of a recent incised wound accelerates or assists union by exciting adhesive inflammation? Does it not rather act as a foreign body preventing union? at least what we reckon one of the greatest improvements of modern surgery, I mean the present mode of dressing of incised wounds, is founded upon that principle. But suppose, that in the special case of arteries, such a stimulus was needed. When that purpose had been effected, how is the now useless, or rather worse than useless clot to be got rid of? By absorption. The author quoted admits that absorption does not go on from the internal coats of arteries, and even the microscopical inquiries of modern times have not been able to show the apparatus of absorption in that tissue. Mr Burns, indeed, gets over this difficulty by the assistance of an incited action, which, says he, "adapts the internal coat for removing by absorption the extraneous substance." This method of getting out of a difficulty, however, will scarcely suffice. No physiologist or pathologist has yet demonstrated that excited action forms absorbents in tissues where they do not naturally exist, and if such a mode of reasoning, or rather assertion without proof, be once admitted in practical subjects, then there will be no check to the career of the medical theorist, for, when placed in a dilemma, he has only to lay hold of incited action, or any other action, (the less understood so much the better for his purpose!) and it will furnish him with ways and means for overcoming all difficulties, and establishing his favourite doctrine.

Let us now examine the opinions of *the second class of writers*; those who believe that the coagulum is a permanent provision in the process of obliteration, and absolutely essential to prevent

secondary hæmorrhage on the separation of the ligature, that without it the adhesions between the divided internal coats would be quite insufficient to resist the impulse of the blood, and that it gradually undergoes certain changes, becomes organised, adheres to the coats of the artery, and eventually renders the vessel an impervious cord. With regard to this view I shall quote the statements of M. Manec, as being one of the most recent and indefatigable investigators of the subject under consideration, and because his opinions are the results of numerous and careful experiments, and his method of detailing the various changes he has observed are full and distinct.

“ 1. The means which nature adopts in permanently closing a vessel, upon which the ligature has been applied, are of two kinds:—1st, The adhesion of the parietes of the vessel to each other; 2d, The formation of a coagulum of blood, which, so soon as it is sufficiently large to fill the vessel, becomes adherent to its internal surface. 2. The means which nature, in the first instance, uses for the prevention of hæmorrhage, after the decidence of the ligature, such as adhesion of the opposite parietes of the artery, or the agglutination of the lips of the divided internal and middle tunics, when a section of these has been made, are invariably destroyed, either totally or partially, by the suppuration which takes place to detach the ligature. 3. The base of the secondary coagulum, generally in contact, and adherent more or less with the agglutination of the arterial parietes, is also almost invariably disorganised and destroyed by the same suppuration; and would thus be displaced and give rise to an immediate hæmorrhage, if it were not of a certain length, or if the union formed with the arterial parietes were not sufficiently powerful to resist the impulsion of the blood. When the ligature is applied too near a collateral branch, the formation of the coagulum is either too small or altogether prevented, and when the membranes are diseased or the vessel has been teased and too extensively insulated during the operation, the union with the arterial parietes is either destroyed altogether, or very feeble in character.”

With regard to organization of the clot he says:—

“ When the artery, upon which the ligature has been applied, is placed under the favourable circumstances which have been pointed out, the first effects of vital impulsion made upon the homogeneous mass of the coagulum, and the coagulable lymph by which it is united to the vessel, begin to be visible between the sixth and tenth hour after their union is completed; and are indicated by the surface of the coagulum and the substance connecting it with the internal membrane of the vessel, assuming a filamentous appearance, which soon becomes areolar. This gra-

dual change of coagulated blood into lamellated tissue, extends through the successive layers of the entire substance of the coagulum; but previously to the central portion having reached this degree of vital organization, red striæ appear in those parts which are nearest the artery. These seem to be absorbent vessels, which slowly and imperceptibly take away the colorific principle of the blood, for the purpose of throwing it into the course of the circulation; and when this substance no longer exists, the striæ lose their colour, become solid and much more resisting than before, and ultimately terminate in forming the basis of the fibrinous web, into which the sanguineous coagulum is always changed. It is probable that each filament is formed of an obliterated vessel. That I might be convinced of the vascularity of the red lines which have been described, I have frequently thrown fine injections into them, using every possible care to avoid detaching the coagulum by the mode of injecting; but I succeeded twice only in passing it from the vasa vasorum into their interior; in the other instances, the injection spread itself over the coagulum, and separated it from the artery. Should the latter circumstance not be considered to authorise the opinion which I have advanced, as to the nature of the real striæ which are found in the coagulum, it does not at least militate against it, any more than the impossibility of injecting the placental from the uterine vessels, does not overthrow the opinion which has been for some time received respecting the double exhalation and absorption which reciprocate between the uterus and placenta."

I differ from these opinions in so far as regards the clot being absolutely essential. In the case which formed the prelude to these remarks, we have an instance of the absence of a coagulum, and yet there had been no return of hæmorrhage for several weeks, and the vessel was found closed by effusion of lymph. But in experiments on animals, I have also not unfrequently found it wanting, whilst the vessel was fairly obliterated. For example, in two vessels, at the 29th day after ligature, in one there is a large coagulum, in the other there is none, yet the latter is equally obliterated. It might be said that this is merely an exception to a general rule depending upon the different circumstances of each particular case, but they are both the carotids of the same dog tied at one operation, so that we can scarcely suppose a case where the vessels could be more equally circumstanced; and that it is not a singular case, I refer to the injected preparation in the possession of Professor Thomson, in which I tied both vertebral and carotids, where the great obliteration of the one carotid in comparison with the other, is referable to a similar cause; here also both vessels were tied at one time, and I might multi-

ply instances of this kind. When the clot is present, however, I believe that the views of M. Manec regarding its organization are correct. The statements of Hunter that he had injected coagula, and the recent and more conclusive investigations of Dalrymple,¹ favour this view, although some still doubt the possibility of this change taking place.

The third and most general opinion, held by Jones, Travers, Guthrie, and others, is, that the permanent obliteration of an artery depends entirely upon the cicatrization of the divided internal tunics, and that the clot is merely an adventitious circumstance, which, when it takes place, may assist, but is not essential to the completion of the process. With regard to this last doctrine, whilst, as I have already stated, I think it sufficiently proved that the clot is not essential, I still believe that something more than the mere adhesion of the cut internal tunics is necessary to the safe completion of the hæmostatic process, and that this has been overlooked by these investigators, chiefly because the nature of the controversy which led to their experiments directed their attention towards particular parts of the process, to the exclusion of what I conceive to be, if not an absolutely essential, at least a very uniform and important part of the process,—I mean the changes which take place on the exterior of the vessel, which, although slightly mentioned by Dr Jones and others, never seemed to have engaged their attention as conducing to the obliteration of the vessel.

If we examine an artery which has been tied, forty-eight hours after the operation, we find it surrounded for a considerable distance above and below the ligature by a deposition of pretty firm lymph, which presses upon and adheres to the coats of the vessel, completely imbedding the ligature, which is deeply sunk between the ends of the artery. At this period the adhesions of the lymph to the arterial parietes, though distinct, are comparatively slight. When examined ninety-six hours after ligature, the effused lymph, though diminished in bulk, has become much firmer, and is, as it were, concentrated round the vessel; and when the external portion is dissected off, we see distinct filamentous bands passing from one end of the vessel to the other around its entire circumference. If examined at the 9th day after the operation, that is, when the ligature is separating, we find that the thread is enveloped in a tubular sheath of lymph, that the deposit round the vessel itself is now very dense and firm, and if the ligature be partially separated, we find that the effusion of lymph has kept pace with its separation, and united the ends of the vessel at the point whence the ligature has separated, immediately behind the thread. On the 13th day, that is, when the ligature has fairly

¹ Transactions of the London Medico-Chirurgical Society, vol. xxiii.

come away,¹ the lymph has assumed the appearance of a firm connecting medium uniting the divided ends of the vessel, not unlike the exuberant callus in a fracture: at the 28th day in some, but later in other cases it has become much absorbed, so that the vessel has now the appearance of a firm impervious cord at that part where the effused lymph formerly existed.

From a consideration of these facts, I am induced to believe that the lymph effused around the artery, is of great importance in assisting the internal changes in the process of obliteration. First, and most obviously, by uniting the divided ends of the vessel, and thus supporting the adhesion of the internal coats at the period of separation of the ligature, for, at that period, a sort of double action seems to go on,—the ligature ulcerating its way out, whilst, at the same time, the reparative process of effusion of lymph keeps pace with the ulceration,—a process in fact analogous to the old operation for fistula, with the gradually tightened wire, the reparative process literally following step by step in the track of the ulceration. There is also another very important, though at first sight less obvious effect which the effused lymph will produce from its very first deposition, viz., by its pressure it will diminish the calibre of the vessel, and thereby lessen the impulse of the blood in the neighbourhood of the ligature.

As to the views I have taken regarding the absorption or organization of the clot, they merely have reference to the present state of our knowledge on these points. I am inclined to believe in its organization, because direct proof has been given that coagula have been shown to become organized. As to absorption of the clot, though I do not mean to say that it cannot take place, we have as yet no proof adduced as to the manner in which such a change could be effected from the internal coats of arteries. There is, however, much to be done in investigating these points, and I believe that the zeal with which microscopical inquiry is now pursued, will be the means of furnishing us with a more accurate and distinct knowledge of the changes which take place both in these and other experiments.

¹ The dates here mentioned, are those at which I examined the vessels which form the series of preparations illustrative of the facts above recorded, and deposited in the Anatomical Museum of the University of Edinburgh.



