AN ADDRESS ON ANEURYSM:

ITS CURE BY INDUCING THE FORMATION OF
WHITE THROMBI WITHIN THE SAC.

Delivered to the Midland Medical Society.

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MR. PRESIDENT AND GENTLEMEN,—My first duty is to thank you for the honour you have conferred upon me in inviting me to deliver the inaugural address of the Midland Medical Society. If anything can enhance such an honour it is the knowledge, on the one hand, that the invitation has emanated from such a great centre of surgical activity as Birmingham, from which so many important advances in surgery have taken their origin, and, on the other, the circumstance of which your President, in sending me the invitation, duly acquainted me, that you have had in former years to inaugurate the opening of your Society a roll of names each highly distinguished in his own sphere, and including men such as Jenner, Lister, Spencer Wells, and Humphry of Cambridge. Having accepted your invitation, I propose to present you with a few facts concerning the Cure of Aneurysm by Inducing the Formation of White Thrombi within the Sac.

In certain regions of the body, such as the extremities, aneurysms can be so treated, by the application of an aseptic ligature applied to the vessel on the proximal side of the aneurysm, that this mode leaves little to be desired. There are occasionally, however, even among aneurysms of the extremities, instances of arterial disease of such a nature and extent as to render the application of a ligature upon a large vessel in its continuity hazardous. A mode of treatment which would subject the patient, under such circumstances, to less risk would be advantageous. In intrathoracic aneurysms the Hunterian operation is impossible, and equally so in a practical sense on the abdominal aorta. Distal ligature for aneurysm at the root of the neck, though many times successful, especially within recent years, involves a serious operation, often complicated by the presence of the tumour, and there are cases in which it has entirely failed in effecting a cure.

For the last fifty years efforts have been directed to effect cures of aneurysm by the administration of internal remedies, by the lowering of the vitality of the body, by starvation, with the object of inducing marasmic thrombosis, and when these failed, as they very frequently did, attempts were made, by acting directly upon the blood stream, to bring about coagulation. It is not intended to give a history of these methods, of which you are fully cognisant; many of them are highly interesting in detail; all of them point towards a common end, and most have in them some elements of success. I shall draw your attention to the last-mentioned method—namely, the endeavour to cure aneurysm by the production of red thrombi.

Most investigators who have endeavoured to effect direct occlusion of an aneurysm by the introduction of foreign bodies into its sac have aimed, as far as the *rationale* of their proceeding is intelligible, at producing such an effect upon the blood stream as to cause coagulation of the blood contained in the sac. When success attended their efforts a red thrombus resulted within a very short period. Retardation or complete cessation of the flow of the blood through the aneurysm greatly facilitates the red thrombus formation, the entire mass of blood coagulating simultaneously. This is seen in popliteal aneurysm where cure results from extreme flexion of the leg upon the thigh. Galvano-puncture, while producing coagulation of the blood at the positive electrode, does not arrest the flow of blood through the vessel, and one important element in the formation of red thrombi is consequently wanting. Failure to effect a cure from galvano-puncture is therefore the rule. Many have preferred to stuff the cavity of an aneurysm with quantities of wire, horsehair, or

catgut, which were intended to effect the double object of acting as foreign bodies, and at the same time retarding the flow of blood through the sac. Some, who employed acupuncture, arranged the pins with the intention of causing an obstruction to the flow of blood, and so favouring the commencement of coagulation.¹

Is a red thrombus formed within an aneurysmal sac best suited for its ultimate occlusion, and are the means at our disposal sufficient to command the production of red thrombi in the presence of a vigorous flowing blood stream? Let us look briefly at the various kinds of thrombi, and the manner in which thrombosis takes place.

A red thrombus at an early stage consists of masses of fibrin enclosing red corpuscles and a few white ones, the whole saturated with serum. As the fibrin contracts this serum is exuded, the mass diminishes in bulk, and though at the outset it may have filled the sac, thereby producing occlusion, yet owing to this shrinking the blood stream may be re-established, especially when the walls of the aneurysm are not collapsible. This has happened in many instances where occlusion lasted some hours, or even days, after which slight pulsation returned, and ultimately the volume of blood passing through the aneurysm became as great as before the formation of the red thrombus. Shrinking continues in this form of thrombus for a considerable period, and may lead, weeks subsequently to the occlusion, to a portion of the channel becoming patent. After occlusion has been effected, the red thrombus, which is simply a mass devoid of vitality, undergoes one of several changes. The blood clot may be acted on in the same way as it would be were it in a wound. It may be penetrated by leucocytes, which absorb the thrombus and replace it by fibrous tissue. This would be the most favourable termination for red thrombi within an aneurysm, but it is seldom seen. The thrombus may undergo red or yellow softening. The former is serious, not only from the conversion of the mass into reddish or greyish disintegrating pulp, but from the fact that some of this disintegrating material may find its way into the blood current and set up emboli. Yellow softening is even worse, as here it is not a mere disintegration of the blood clot, but an intense inflammation of the walls of the vessel, ending in pus production, dependent, in all probability, on septic contamination. The wall of the vessel participates in the softening process, when the blood may burst into the surrounding tissues. The blood current may also carry portions of septic detritus into the circulation, causing septic infarctions. The latter form of softening is to be guarded against by preventing septic matter being introduced from without, and by rendering aseptic, prior to operation on the aneurysm, any sore, abscess, or suppurating ear which the patient may have. White thrombi are not liable to either of these forms of softening; the first could scarcely occur in them, while the second is preventable.

The attempts to produce coagulation in aneurysmal sacs by the introduction of foreign bodies into their interior, although occasionally successful, have failed as a rule, especially in aneurysms at the root of the neck or where the circulation could not be controlled on the proximal side of the sac. Those who have endeavoured to produce red thrombi for the purpose of occluding an aneurysm under these circumstances have omitted one of the most important elements, without which success cannot be secured, namely, placing the blood in the sac in a state of rest. In intrathoracic aneurysms and those at the root of the neck the arrest of the blood stream is an inherent impossibility, except by occlusion of the sac, and therefore in them this mode of treatment is not applicable. When red thrombi are formed in the presence of a vigorous blood stream they are more liable to disintegration and absorption than to organisation. It is in this way the red thrombus formed on the positive electrode by galvanism is so often of no benefit.

But why are there some successes complete or partial, and how do these arise? It is due to those successful stray cases that a wavering belief in this line of treatment still lingers. In the majority of such subjected to pathological examination at various periods subsequent to the complete or partial cure, the sac has been found to contain white thrombi, which, it is assumed, resulted from organisation of the red thrombi. While not doubting that red thrombi may have organised tissue substituted for them, I believe that in many such the white thrombi have originally formed as such, and were caused not intentionally by the operator, nor from any effect upon the blood stream, but by accidental cir-

¹ See article by Mr. Heath in his *Surgical Dictionary*, vol. i. p. 89.

circumstances quite apart. Thus, for instance, in certain aortic aneurysms treated by galvano-puncture, white thrombi have been noticed developed upon the points punctured by the needles. These were attributed to the galvanism, whereas they were due to the damaged vessel wall setting up a reparative inflammatory process. This interpretation of the phenomenon receives support from the fact that white thrombi may be produced by penetration of the vessel wall without galvanism. Let us look briefly at the characters of white thrombi.

When the current of blood is unobstructed, white thrombi are prone to form in the interior of a vessel at a spot where irritation has been induced, and from which the endothelium has been removed. At such a part leucocytes derived partly from the vessel wall, but mainly by segregation from the blood stream, become firmly adherent to the vessel. When this process has been initiated it tends to grow by superimposed accretions, so that a parietal thrombus may proceed until complete occlusion occurs. The leucocytes shortly after their deposition disintegrate into a finely granular fibrin, which shrinks, but the shrinkage is by no means so great as that which occurs in red thrombi. Where the shrinkage is completed, the white thrombus chiefly consists of an inert body, capable of and subject to further transformation.

The various forms of softening to which red thrombi are subject seldom affect white thrombi. Were the damage to the vessel wall or surrounding structures excessive, puriform softening could occur, especially in the presence of septic matter. The latter is, in the majority of cases, avoidable.

The white thrombus is prone to undergo replacement by vascularised fibrous tissue, the granular fibrin originally deposited becoming absorbed and taking no share in the new formation. The first step in the process is the infiltration of the vessel wall with the leucocytes derived from the vasa vasorum and neighbouring vessels. These penetrate the thrombus, becoming converted into formative cells which develop into fibrous tissue, abundantly supplied with blood vessels. In this way a thoroughly vascularised connective tissue blended with the vessel wall is formed throughout. The vessels of this new formed fibrous tissue are continuous with those of the vasa vasorum.

A good specimen of this highly vascularised connective tissue may be seen in the case of femoral aneurysm referred to hereafter. It is possible when in an aneurysm the parietal thrombus in process of development has reached the level of the internal surface of the normal arterial tube, that it may become covered by endothelium. If so, a new channel would be formed with very thick external walls.

The restoration of the lumen of the vessel, while securing the cure of the aneurysm, would be an ideal result which, however, has not yet been obtained. That the thrombus, especially after its development into fibrous tissue, could become covered by endothelium is evident; but under favourable circumstances it may even occur while the thrombus is in an early stage. A somewhat analogous process is sometimes seen on the surface of a wound; fibrinous exudation containing many leucocytes may become covered by a layer of epithelium, the formation of the latter keeping pace with the advance of the living infiltrating leucocytes. What occurs with epithelium may take place with endothelium under favourable conditions.

Not infrequently in the ligature of an artery the endothelium has been seen to cover the free portion of the thrombus. It is true that in aneurysms undergoing natural cure the thrombi are very slowly and imperfectly replaced by fibrous tissue. In the young, the transformation of white thrombi into fibrous tissue takes place more quickly than in the old with degenerate arteries. In some of the former the accumulation of leucocytes at the damaged wall may be so rapid and so great as to assume the appearance of granulation tissue.

When there are extensive calcareous plates in the walls of a vessel or an aneurysm, the formation of white thrombi is seemingly delayed, and when formed they seldom pass into a vascularised state, owing probably to the dead calcareous matter intervening between the thrombus and the vessels of the vasa vasorum.

The deposition of white thrombi occurs so slowly that in large aneurysmal sacs it is, as a rule, many months before occlusion takes place. The thinner the layers of white thrombi formed on the wall of the vessel, the more easily will its organisation be effected; therefore, the slower the process—other things being equal—the more surely will organisation follow in its wake.

If one could so regulate the depositions as to ensure organisation of one before the next was superimposed, it would be advan-

tageous in cases where no urgency exists. Even in large thrombi, however, organisation takes place and may become complete. Formative cells may be found developing in white thrombi in the lower animals a few weeks after their formation. In the course of time the connective tissue which has replaced the thrombus shrinks very considerably, so that what has been a large solid tumour quickly becomes reduced to a diminutive size.

It is therefore seen that a thrombus formed by acting on the contents of an aneurysmal sac is different from one induced by acting on its walls. The introduction of foreign bodies into the sac of an aneurysm in which the blood is freely circulating, with the object of forming red thrombi, is not the most certain way of producing permanent occlusion of the vessel. White thrombi are more suitable for permanent aneurysmal occlusion under such circumstances. Granting the aim to be to secure a white thrombus in an aneurysmal sac, how can this be accomplished? This may be done by irritating the wall of the aneurysm in such a way as to induce infiltration of the parietes with leucocytes, and a segregation of them from the blood stream at the point of irritation. The irritation ought to be just sufficient to set up reparative exudation, and must not exceed this. If the irritation be pushed to such an extent as to induce softening of the vessel wall, not only would the object be frustrated, but the pressure of blood from within might cause the aneurysm to burst.

While it is true that once the white thrombus has been formed in the interior of an aneurysm, it tends to grow by successive accretions, and by starting at a small irritated point in the wall of the distended vessel it might ultimately cause complete occlusion. Yet it is better to act upon the wall of the aneurysm, so as to produce either a uniform irritation over its whole surface or to stimulate as many points in its interior as possible. In this way many foci will throw out white thrombi. At all such places the wall of the vessel is being strengthened and preserved from further dilatation. It is well, if possible, to secure foci all over the sac for another reason. Were a white thrombus formed in one part of the sac alone, it might be possible for the blood pressure to be exerted all the more on some other part of the sac not so protected, and so, in the case of a very thin wall, damage might result.

It would be well, therefore, to ascertain as far as possible the form and dimensions of the aneurysmal sac before inducing plastic effusion at any one part of it. This may be readily done beforehand in aneurysms of the extremities; but in those of the trunk and root of the neck it in many cases can only be ascertained by investigation within the aneurysm itself. Fortunately, a very fair idea may be gained by the very instrument which is intended to induce the cure, and at the same time as the latter is set agoing.

The means hitherto employed to effect this purpose have been very simple. The instrument employed is a pin of sufficient length to completely transfix the aneurysm and to permit of manipulation within it. Its calibre ought to be as fine as possible, the strength being only sufficient to penetrate the coat of the aneurysm and the intervening tissues. This cylindrical pin tapers to a point like an ordinary sewing needle, and has on its opposite extremity a somewhat rounded head. As the coats of aneurysmal sacs vary in thickness, these pins must be made of various calibres, as those which may pass readily through one aneurysmal sac may not pass through others with thicker walls. They ought also to be finely polished, not only to facilitate their introduction but to help to render them aseptic.

Before performing the operation, the skin over the aneurysm ought to be carefully cleansed and rendered aseptic. The aseptic pin ought then to penetrate the sac and pass through its cavity until it comes in contact with the opposite side. It ought to touch the opposite side, and no more. Then one of two methods may be employed: either to move the pin over the surface of the inner wall so as to irritate its surface, or to allow the impulse of the blood current playing on the very thin pin to effect the same object. If the wall penetrated by the pin on introduction be dense, the former method will be preferable, as the force of the blood current produces such a feeble action on the thin pin as to be insufficient to move it to and fro while it is firmly grasped by a dense wall. After acting thus for ten minutes at one part, the point of the pin, without being removed from the sac, ought to be shifted to another spot, and so on until the greater portion of the internal surface opposite to the point of entrance has been acted upon. This ought to be done in a methodical manner. A single insertion of the pin through the

aneurysmal sac into its interior may be sufficient to enable the point of the instrument to come into contact with the greater part of its internal surface, but in some cases punctures from various sides of the external wall may be necessary so as to reach portions of the tumour which cannot be attacked from the first puncture. While the pin is in the aneurysm, it is surrounded by a portion of aseptic gauze, dry or moistened with an antiseptic solution. When it is withdrawn from the aneurysm, the part ought to be covered with moist antiseptic dressing, preferably a watery solution of carbolic acid, which ought to be maintained for several days.

The period a pin may remain in an aneurysmal sac without doing damage is, perhaps, dependent on the individual and the state of the aneurysm, but it ought never to exceed forty-eight hours. It is questionable whether all the necessary advantages derivable from the irritation of the wall of the aneurysm could not be produced within a few hours. No doubt its retention for twenty-four or thirty-six hours seems to produce a greater immediate effect.

If the aneurysm be very large, several pins may be introduced from various points, always allowing a considerable interval to exist between each, otherwise there might be too much damage to the vessel wall at one spot. In some instances the point of the pin has been engaged in the opposite wall of the aneurysm, and has thus produced sufficient irritation. It need scarcely be said that the general health of the individual, the condition of the aneurysm, and the surrounding tissues, ought to be carefully examined before commencing the treatment. If there be anything wrong with the health which could be put right before operating, that ought to be done. No one would think, for instance, of introducing pins into an aneurysm which was inflamed, or where the tissues in the vicinity of the aneurysm were in a state of erysipelas. It would also be necessary to render aseptic any sore which the patient had in other parts of the body.

Fig. 1.—Pin inserted into aneurysm, showing how pin may be moved from one part to another without withdrawing it from sac.

When the pin has been withdrawn, though there may be a little thickening of the tissues in the neighbourhood, there will probably be little or no diminution of the eccentric impulse. Occasionally it may be weeks before any distinct and tangible thickening of the coats can be made out. In other instances this may be discernible at a much earlier period; but, as a rule, a distinct thickening of the coats of the vessel is tangible at an early period. It has occasionally happened that some weeks after the first introduction of the pin the walls, though thickened, appeared to be so only to a slight extent, whereas when a second puncture of the sac was made a much stouter pin was required to penetrate the thickened coats than the one which, on the first occasion, slipped easily through the walls of the aneurysm, showing that there was a greater thickening than what was indicated by external palpation. Further, in one instance, had the amount of dense fibrous tissue within the aneurysm been rightly appreciated, it is probable that a death from suffocation would not have been permitted, at least, without an endeavour being made to save the individual by operative means.

It is also to be borne in mind, especially in deep-seated aneurysms, that the thickening appreciable on the external surface of the sac through which the pin has passed is much less, as a rule, than that on the part of the sac acted upon by the point of the pin, and, therefore, the one furthest away from the point of entrance,

and which cannot be reached by manipulation. This irritation of the coats of the aneurysm has been in some of my cases many times repeated at intervals of weeks, and in one case of months, with the view of hastening consummation of the cure. Though there was apparent advantage after each, it is doubtful whether the formation of white thrombi once fairly started was not going slowly on independent of this secondary interference. It is clear the coats of the aneurysm cannot be reached by the pin after they have been covered by a thick layer of white thrombi. The extremity of the pin must therefore come in contact with the dead thrombi alone. Were the previous layer of thrombus vascularised, then the secondary introduction of the pin would be of service in coming into contact with living tissue, and setting up in it fresh irritation and fresh deposition of white thrombi.

In introducing pins care ought to be taken to avoid injuring important structures which may be overlying the sac. The cords of the brachial plexus may be raised by an aneurysm at the root of the neck. It would be necessary, in order to prevent pain, to insert the pins apart from them. Where the aneurysm is inaccessible from without this mode of treatment could not be applied, but most of the aneurysms of the chest whose physical features can be made out and whose limits are clearly defined, may be subjected to this form of treatment. When a sac is covered by calcareous depositions it is possible that these may exercise a deterrent influence on the production of thoroughly organised connective tissue forming in the thrombus. The younger the patient, other things being equal, the more quickly would the white thrombus form. Suppose complete consolidation may not be effected by the treatment, the thickening of the coats of the aneurysm may prolong life, especially if that thickening be uniform.

Though this method has been adopted of producing the necessary effect upon the wall of the sac, any other mode of carrying out the principle of the treatment—the occlusion of the sac by the formation of white thrombi and its consequent organisation into living tissue—might be used provided it showed any advantage. One would be inclined by preference to use any means which, while being equally successful and easily applied, would do away with the necessity of penetrating the sac.²

² It must be pointed out that the method of inducing the formation of white thrombi within the sac is different from the mere acupuncture which has been employed by several surgeons, chiefly with the view of inducing coagulation of the blood. Pins were used by me for the induction of white thrombi within an aneurysmal sac first in 1875, the case being published in the *Glasgow Medical Journal* in 1876, and in the *Lancet* for 1877. Mr. Christopher Heath reported a case in January, 1879, in which he used pins crossed so as to arrest the circulation of the blood. The patient died 17 days afterwards. His aneurysm was filled with dense fibrin. Mr. Marshall introduced a number of very small gold pins into a sac some time anterior to Mr. Heath's case. His patient though improved was not cured. Mr. Chauncy Puzey, of Liverpool, tried pins during seven weeks in an innominate aneurysm in 1880; the patient died seven weeks after from chronic cellulitis.

(To be continued.)

MEDICAL STUDENTS IN GERMAN UNIVERSITIES.—According to the recently published official *Universitäts-Kalender*, the total number of medical students in the twenty universities of Germany during the summer semester of this year was 9,288, as against 8,714 in the winter. They were distributed among the different universities as follows: Munich 1381, Berlin 1184, Würzburg 997, Leipzig 894, Freiburg 453, Greifswald 421, Bonn 400, Erlangen 359, Kiel 353, Heidelberg 350, Breslau 330, Strassburg 304, Halle 300, Marburg 273, Königsberg 271, Tübingen 261, Jena 230, Göttingen 214, Giessen 167, and Rostock 146.

WATER AT THE PYRAMIDS.—It has been objected to the proposed suggestion to obtain a purer water supply for Cairo—that is, for nearly half the present population of Egypt—by sinking wells at some distance from the city, on the margin of the desert, that such a course would not only be wholly inadequate, but would be in fact the same Nile water percolated through the sand. The architect of the Mena Hotel, near the Great Pyramid, has made preliminary borings there, which yielded a water which, analysed in the Khedivial laboratory, was pronounced to be of excellent quality. The amount, however, was insufficient. A deep well, constructed of brick-work and cement, has now been made, from which, by means of a Worthington steam pump, a supply described as “practically inexhaustible” is obtained. This intelligence is the more satisfactory, as we have already indicated on general grounds that the “margin of the desert” was the most desirable location for such sinkings.