On the rapid method of cure of external aneurism by means of the elastic bandage : with a table of seventy-two cases / by A. Pearce Gould.

ON THE

RAPID METHOD OF CURE

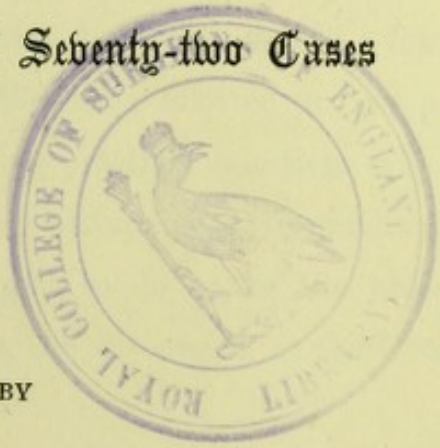
OF

EXTERNAL ANEURISM

BY MEANS OF

THE ELASTIC BANDAGE

With a Table of Seventy-two Cases



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PREFACE.

THE Treatment of Aneurism by Esmarch's Elastic Bandage was one of the subjects chosen for discussion in the Surgical Section of the recent International Medical Congress, and I was permitted to contribute a Paper to that discussion. As I have been able to add a few cases to the Table then presented, and as the time allotted to me prevented my touching on some of the interesting practical questions which arise in a consideration of this subject, I have ventured to publish the present paper. I have been specially urged to do so, as the objections raised against this mode of treatment in the discussion at the Congress do not appear just.

I have to acknowledge the courtesy of Mr. Oliver Pemberton, Mr. F. A. Heath, and Mr. Croft, in furnishing me with information of cases under their care.

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ON THE

CURE OF EXTERNAL ANEURISM

BY THE ELASTIC BANDAGE.

CHAPTER I.

INTRODUCTION.

In 1864 a case of aneurism of the abdominal aorta came under the care of Dr. Wm. Murray, of Newcastle, who, finding that he was able to control the pulsation in the tumour by digital compression of the vessel above it, formed, and carried to a successful issue, the plan of completely stopping the flow of blood into the aneurism by instrumental pressure—pain being allayed by anæsthesia—and so introduced what he termed "the rapid method" of treating aneurism. In his description of this case and method,* Dr. Murray particularly points out the nature of the curative process, and remarks that the "*principle* on which the rapid method rests is clearly the complete stagnation of a mass of blood in the aneurism until it coagulates. Whether this is to be done under chloroform or without it; whether by pressure both above and below, or only above the sac; and whether the pressure is to be made by the hand, by flexion, by a weight, or by a tourniquet, are questions which in no way touch the principle on which the treatment is based."

In the limited class of internal aneurisms where this rapid method is practicable, it has been tried in several instances. In 1865 Dr. E. D. Mapother attempted to carry it out in the treatment of external aneurisms, and recorded two successful cases in the *British Medical Journal*, 1867, vol. ii. But he lacked easily applied safe and efficient means of entirely stopping the circulation in the part, for in each of his cases the compressor caused a local slough; and it was not until ten years later that the introduction of Esmarch's elastic bandage supplied this want. In 1875 Staff-Surgeon Walter Reid, R.N., operated on a case of necrosis of the femur, and during the whole period of the operation, which was protracted to over an hour, the limb was kept quite anæmic by means of Esmarch's elastic tourniquet. Having a case of popliteal aneurism in the hospital at the time, it occurred to Dr. Reid that this same tourniquet would be a ready and safe means of keeping the sac full of

* "The Rapid Cure of Aneurism by Pressure." By W. Murray, M.D., &c. 1871.

stagnant blood for a time sufficient for its coagulation. Accordingly, next day (September 11, 1875), at 10.20 A.M., he "bandaged the limb with the elastic roller, from the toes upwards to the junction of the middle with the lower third of the thigh. It was applied lightly over the aneurism, so as not to compress it. The elastic tubing was then wound round the limb over the highest turn of the bandage, which was now removed. The entire circulation below the tubing was found to be arrested. The limb had assumed a death-like pallor, and gradually lost temperature. The aneurism was of its usual size, and pulseless. After fifty minutes, the patient complaining of severe pain above the seat of constriction, a Carte's compressor was adjusted to the main trunk at the pelvic brim, and the elastic tubing removed."* The aneurism was now found to be pulseless, and several small vessels round the knee-joint were felt beating strongly. Carte's compressor was applied lightly and intermittently, so as not to distress the patient, till the next evening, when all treatment was suspended, and the aneurism was cured. Dr. Reid, referring to the case, remarks:—"The explanation appears to be—the coagulation of the blood in the sac, consequent upon its complete stagnation. The aneurism itself probably remained full, but the entire circulation in the parts was arrested. . . . . My reason for compressing the main trunk for some time afterwards was that the force of the blood-current might have broken down and washed away the newly-formed clot before it had time to become tough and solid, and the sac to contract over it." From these quotations it is demonstrated that Dr. Reid clearly appreciated the principles involved in the practice he initiated, and those who have followed him have not been able to make any important additions to the details to be observed to insure success. This first case was so strikingly successful that the method was soon employed in other cases by other surgeons, but it is not until quite recently that continental surgeons have availed themselves of this latest development of the plan of treating aneurisms by compression. I have collected more than seventy cases of external aneurism treated by Esmarch's bandage, which have been recorded more or less fully, and they will be found arranged in a tabular form at the end of this paper. That table of cases, with the description of the pathological evidence available, and an examination of the specimens themselves, where possible, is the basis of this paper. The most striking facts springing from even a casual survey of the table are that, while a large number of aneurisms have been very rapidly cured by this treatment, its success has been by no means uniform, even in cases apparently alike; and that different surgeons have modified the plan originally carried out by Dr. Reid in various ways. The time appears to have come when an examination into the causes of success and failure, the cases best adapted for the treatment, the exact method in which it should be carried out,

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* *Lancet*, 1875, vol. ii. p. 448.

and the dangers (if any) attending Dr. Reid's adaptation of Dr. Murray's "rapid method," may be made with advantage.

The most suitable order in which these facts and considerations may be dealt with is, first, to note the *modus operandi* of the treatment—its pathology, its rationale; then to study the causes of its failure in so many cases; then to note, and in some cases to meet, the objections that have been urged against it, and the advantages it has over other comparable plans of treatment; and, lastly, by a detailed and statistical study of the table, to try to ascertain what vital differences in the aneurism and in the constitutional state of the patient, and what details in the treatment, are of importance.

While the table contains all the cases that I have found recorded in the literature accessible to me, it is probable that the elastic bandage has been employed in many—possibly in very many—cases of aneurism of which no record has been published. For this reason, any deductions based on these statistics alone are only relatively, not absolutely, trustworthy.

CHAPTER II.

PATHOLOGY.

Since the days of Hunter, and the almost entire abandonment of the operations of amputation, and incision or excision of the sac with double ligature of the artery, surgeons have sought the cure of aneurisms by so acting upon the circulating blood as to cause it to solidify in, and occlude the sac. The occluded sac—no longer now an aneurism—has then undergone more or less perfect absorption. Whether we regard the ligature applied above or below the tumour, close to or at a distance from the sac, or the various forms of compression, manipulation, and injection, we find that they are one and all practised with this object in view. And the latest modification in the treatment of aneurism is no exception to this rule; it, like all the others, seeks to secure occlusion of the aneurism by solid matter derived from the blood itself.

The only way in which a solid substance is known to be produced from the blood in the living body, is by the separation of fibrin. If drawn blood be kept at rest and coagulation allowed to take place in the usual manner, the fine filaments of fibrin forming in every part of the mass of blood enclose the red and white blood corpuscles in their meshes, and a blood-clot is the result, which, consisting at first of fibrin, corpuscles, and serum, speedily commences to contract and gradually expresses the serum. If, on the other hand, the blood be kept constantly agitated by rapid stirring, the fine filaments of fibrin cling to the "whip," and the corpuscles and serum are freed from the fibrinous meshes —shaken out of them; and the solid substance then formed is pure fibrin, the

corpuscles and serum remaining in a liquid state. The chemical change in the two cases is precisely similar, the difference in result is due entirely to the fact that in the one case the corpuscles being at rest are entrapped by the forming fibrin, while in the other the rapid agitation frees them from its meshes.

This being a merely physical effect, we find it the same in the living body. When the fibrin separates from blood at rest, it forms a blood-clot by enclosing in its meshes the corpuscles, and at first also the serum; but when the separation takes place from blood in rapid and turbulent motion, the fibrin is freed from corpuscles. Thus, in a ligatured artery, the blood clots up to the nearest large branch; but tips of fibrin only are deposited on inflammatory vegetations on the valves of the heart from the fast-flowing blood, and blood whirling through an aneurism leaves a lining of fibrin only.

In considering any mode of cure of aneurism, the many distinctions between pure fibrin and blood-clot must be kept clearly in view. Not only are they unlike in the conditions causing them, and in their composition and appearance, but also more remarkably in their vital properties. Fibrin is best seen in the lining of the sacs of the large aneurisms occurring in the thorax and belly. Here, from its appearance, it is usually called laminated fibrin, the concentric lamination being due to its separation in successive layers. If the several layers of such laminated fibrin are examined, it is found that they can be readily separated from one another and the sac wall, and that they hardly differ from one another at all. In other words, the outer part of the fibrin—the old fibrin—has not undergone any marked change; it has not become organized, or softened, or disintegrated, but remains almost identically the same as when first separated from the blood. Such unaltered fibrinous deposits are also met with tipping "vegetations" on the valves of the heart, and on other diseased or foreign surfaces in contact with circulating blood.

The behaviour of intravascular blood-clots—for only these are comparable with aneurismal clots—can be studied in venous thrombi, where, however, the element of inflammation is sometimes added, and, better, in divided and occluded arteries, as, *e.g.*, above a ligature. In such a case we find the clot homogeneous and continuous—not separable into layers. It generally quickly becomes adherent to, and organically connected with, the vessel wall, while its substance rapidly becomes crowded with leucocytes, and undergoes organization into—or is replaced by—vascular cellular tissue, which is gradually in part absorbed. In some cases of venous thrombosis the clot becomes absorbed or disintegrated—at any rate, the plugged vein again becomes pervious, and the clot, which previously blocked it up, disappears without producing any embolic effects. If the inflammation, however, continue, and be intense, suppuration of the vein may occur. If we look at the changes which blood-clots formed outside the vessels undergo, we see that they are either absorbed, or, becoming encapsuled, remain as inert dry friable partly-

decolorised masses. These facts are all of them of interest as bearing upon the particular subject under discussion, for we shall see that by a knowledge of them we shall be able to explain the varied experiences obtained in the many attempts to cure aneurisms by Dr. Reid's treatment.

We may formulate these points thus:—*Laminated fibrin is only separated from blood in motion; when once formed it is very stable, not prone to disintegration or to organization. Blood-clot is only formed when the blood is at absolute or partial rest; and when formed the clot is unstable, readily being organized, disintegrated, absorbed, or converted into a dry friable material.*

The means hitherto employed in the treatment of aneurism have chiefly aimed at the obliteration of the sac by a gradual deposit of laminated fibrin, Dr. Murray's "rapid treatment," manipulation of the sac and injection of coagulants, being the only exceptions. But the history of some cases of digital and instrumental compression makes it abundantly clear that the cure has really taken place through sudden clotting of the blood, for sometimes after treatment has been long continued and unavailing, the aneurism has very rapidly, and even suddenly, become solid and pulseless. With the means at the surgeon's disposal, Dr. Murray's "rapid treatment" has been of but very limited application; that its principle was the attainment of stasis of the blood in an aneurismal sac for a time sufficiently long to allow it to coagulate *en masse*, there can be no doubt.

Reid's Treatment is usually spoken of as a variety of the "Compression Treatment;" but as a distinct appreciation of the special effects it produces both locally and generally—effects widely different from those of digital or instrumental compression, or even the ligature—is necessary to its successful application, it will be well to note these points of difference in detail.

If we take the common case of a popliteal aneurism, treated by digital compression of the femoral artery at the groin, we observe that the main artery is more or less perfectly obliterated at one point, that care is taken to have the compressing force limited to the artery, and not to act upon the companion vein if possible; the anastomotic circulation is not interfered with, and therefore the blood soon finds its way into the femoral artery below the finger, and flows through the aneurism in a gently trickling stream. This compression has to be continued for many hours, or at intervals for days or even weeks, and it usually succeeds as well (though not so quickly) when intermittent as when continuous. When successful, the aneurism is found to become gradually firmer with lessening pulsation, until at last it loses pulsation altogether, its thrill and bruit are no longer perceptible, and the tumour is solid; then the artery from which it springs becomes occluded, and those around the knee-joint are found to become enlarged and carry on the anastomotic circulation; and ultimately the lump in the ham disappears altogether, or remains as only a small, hard, non-pulsatile tumour. If the artery is ligatured, the effects are the

same—the main channel alone is obstructed, and the flow through the collateral vessels being unimpeded, soon causes a stream of blood to pass into the main vessel below the ligature. The usual change produced in the aneurism is a gradual deposit of fibrin in concentric laminæ until its cavity is occluded; and then the process spreads to the artery, where the growing obstruction quickly produces stasis, and the formation of a true blood-clot. This clot becomes organised, and the fibrin in the aneurism undergoes more or less complete absorption. In some cases, as already mentioned, during compression of the artery above, blood has coagulated *en masse* in an aneurism. But this is not usual, nor is it aimed at in applying this kind of compression.

Compare with this a case of popliteal aneurism, treated successfully after Dr. Reid's plan. The elastic bandage is applied firmly from the roots of the toes up to the lower part of the ham, then it is intermitted or applied only very lightly over the aneurism, while above the tumour it is applied very firmly to about the middle of the thigh, and then, if there is still any trace of pulsation in the sac, the elastic tube or tourniquet is applied tightly until it ceases. After about an hour this apparatus is removed, and the aneurism is then found to be firm and not pulsating; compression is applied to the artery at the groin for from six to thirty-six hours, during which the tumour shrinks; pulsating vessels are soon detected around the knee-joint, and quickly the aneurism disappears altogether. In this account I have purposely omitted the many lesser details to be alluded to further on. The first thing to be noticed is that the compression is applied not to one spot of one vessel only, but to all the vessels of the limb in their whole length, except just at the site of the aneurism. Experience of the elastic bandage in amputations and excisions shows that it expresses the blood from all the vessels of the part to which it is applied, and arrests all circulation through them, both direct and anastomotic.

Indeed, it is evident that its effects are first and mainly felt by the capillaries and smaller vessels, and that the larger arteries are the latest to be emptied by the pressure. In the case we have supposed, then, the vessels of the foot, leg, and lower half of the thigh, will be emptied more or less completely, while those in the ham and around the knee-joint will be full of blood; but as the circulation both above and below the ham is entirely arrested, this blood will be stagnant, and no emptying of the full vessels or movement of the blood will be possible. The primary effect, then, of the bandage is to distend the aneurism and adjacent vessels with stagnant blood. The blood in the aneurism coagulates, and the clot spreads into the artery; but the blood in the other vessels—although stagnant and exposed to many of the same influences—remains fluid. If the bandage is applied as we have described, laminated fibrin cannot be formed; the fibrin must enclose in its meshes the corpuscles, and form a true clot. The fact that this treatment causes absolute stasis of blood in the aneurism and adjacent vessels for a certain time, which allows of coagulation

of the blood *en masse*, distinguishes it from every other treatment for external aneurism yet introduced. In successful cases the part of the clot in the artery organises, but that in the aneurism is for the most part absorbed. We may say, then, that in the cure of the aneurism treated by this method there are four separable steps :—(1) the stasis of the blood in the aneurism and adjacent vessels; (2) the clotting of the blood in the aneurism and adjacent artery; (3) the organisation, and (4), later on, the absorption of the clot. We must, therefore, endeavour to ascertain the circumstances causing, favouring, or preventing each of these events.

To cause the stasis of the blood—a purely physical effect—the only thing necessary is the proper application of the elastic bandage. But it is important to notice the different parts played by the bandage below and above the aneurism. In the case of a popliteal aneurism the elastic bandage or tourniquet, applied sufficiently tight around the thigh, will, of itself, cause stasis in the whole of the limb below; and in Cases 7 and 56 this simple method was adopted. In all similar cases it is the bandage above the aneurism that is the sole means of causing stasis in the sac, and is therefore the essential part of the application. What, then, is the use of the bandage below the sac? It empties the vessels of the part, forcing blood into the general circulation, and so causes the limb to be practically bloodless during the application of the bandage above; and it in no way affects the stasis, or the condition of the aneurism, except that it favours its distension when the pressure is applied above. It has been suggested by Mr. C. Heath* that distension of the aneurism may aid the coagulation of the blood; but he has not adduced any evidence in support of the suggestion, and it would seem that any such supposed advantage is more than compensated by the risk of rupturing a very thin sac. It may be, however, that circular compression of the limb just below the aneurism may cause the stasis to be more perfect than it would otherwise be, for without it the dilatation of the vessels from vaso-motor paralysis, owing to the cessation of the circulation, might cause gentle and slight ebbs and flows in the blood. Again, the bandage below the sac certainly prevents capillary rupture from the compression of the limb above, such as has been shown to occur around the aneurism (page 23). A simple modification, which answers these purposes, and without the disadvantages of keeping the whole limb bloodless and of forcing an undue quantity of blood into the general circulation, is to apply the elastic bandage to the limb only immediately below the aneurism and while the part is horizontal. This will not over-distend the vessels below, and will prevent the least emptying of the aneurism. If the upper bandage is then applied to the limb in the vertical dependent position the aneurism will be distended, if that be desired.

Another way of obtaining this stasis in the aneurism was practised

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* *Clin. Soc. Trans.*, 1880.

in Cases 60, 65. It consists in applying the elastic bandage quite up to the sac, and then, with the finger or some mechanical appliance, compressing the artery close above the sac. In this method it is the lower bandage that is the important and essential part. The compression of the main trunk does not cut off the supply of blood through the various anastomosing channels, but all such anastomotic circulation is entirely prevented by the compression of the vessels below the sac. The compression of the main artery in such a case is of use only in entirely preventing the shock of the ventricular systole, which would otherwise be transmitted to the blood in the aneurism, and cause some commotion in it. It is a reversal in this particular of the common method. There the compression above the aneurism is the essential, that below is accessory only; here the compression below the sac is essential, and that above accessory. This method is employed in aneurisms so placed that the elastic bandage can be applied up to, but not above, the aneurism, and when the main artery can be readily controlled close above the sac; these conditions are exemplified in aneurism at the apex of Scarpa's triangle (case 60). The same method has been employed for an aneurism of the external iliac artery (No. 65); Lister's tourniquet being applied to the common iliac artery. In this case, however, although the result was successful, it is to be noted that the anastomotic circulation through the epigastric and circumflex iliac arteries was not in any way controlled. Dr. Reid's treatment is, of course, inapplicable to aneurisms of the neck, for the special kind of compression cannot be employed in this region.

Then comes the question—

Why does the blood coagulate? What condition is it that leads to the escape from the corpuscles of the ferment that has the power of exciting the union of fibrinogen and fibrinoplastin? It is not the stasis of the blood in the living vessels; it is not the cessation of all circulation of blood through the vessel-walls themselves, for Mr. Lister's experiments have shown that blood can be kept fluid for a long time in veins removed from the body, even when open to the air; indeed, it is evident that the cause of the coagulation is not in any condition of the vessels themselves, for the stagnant blood does not coagulate in the veins, or in arteries other than the one diseased. Further, it has been found in some cases that on removal of the bandage the aneurism has been only partially consolidated, with lessened pulsation, while in others the aneurism has become solid, but has exhibited pulsation transmitted from the connected artery; but in no case has it been noticed that the blood in the aneurism has remained fluid, but free from pulsation owing to the thrombosis in the artery. And hence we may conclude that in all cases the coagulation starts in the aneurism, and that the clot may partially or completely fill the aneurism, or extend into the artery; and that the clotting never commences in the artery itself. When the blood is in motion the flow through an aneurism is more irregular and turbulent than through an

artery, and this may have some influence upon the formation of fibrin; but when the blood is stagnant, as in the case in point, the only differences between the two are those of contour and structure. As an aneurism usually is in shape a nearer approach to a globe than is an artery, the surface contact of the contained blood is proportionately less. This, then, will not explain the coagulation in the aneurism. We must, therefore, look to the differences in the structure of the two; the absence of endothelial lining in the aneurism, its want of perfect smoothness, or the presence of fibrin on the inside of the sac, or some special vital reaction of the tissues of the sac upon the blood, may one or all be regarded as tending to start coagulation. Clotting, once started, would tend to spread through all the stagnant blood, and therefore into the artery, but rapid circulation through the artery would entirely prevent it there; we see this illustrated in the case of a ligatured artery, in which the clotting starts at the rupture of the two inner coats, and spreads up through the stagnant blood, but is sharply limited by the mouth of the first large branch—*i.e.*, where the blood is flowing rapidly.

While much may depend upon the exact nature of the aneurismal sac, may not something depend upon the blood itself? Does not the blood vary in plasticity—its tendency and power to coagulation? The evidence on this point is difficult to obtain; much of that adduced is vitiated by the objection that the condition associated with changed "plasticity" may exert its effects not directly on the blood, but indirectly through the surrounding tissues. But at any rate it is asserted that physiological and pathological states, such as pregnancy, parturition, acute rheumatism and pyæmia, and drugs such as iron and iodide of potassium, cause hyperinosis; while syphilis, starvation, alcoholism, overwork, erysipelas, gangrene, and mercurialism, lessen the amount of fibrin in the blood. The clot, being induced by some action of the aneurismal sac on the contained blood, may possibly vary in extent, in rapidity of formation, and in some other characters, such as consistence, with the varying composition of the blood itself.

We have not to rely upon theoretical considerations only in support of this argument. In *all* the cases of aneurism treated by this method that have been examined after death, true blood-clot, and not laminated fibrin, has been found in the sac and artery. These cases are not many, but as they all agree precisely on this point, their evidence is practically conclusive.

In Dr. Weir's case (No. 30), where death occurred twenty-seven hours after removal of the elastic bandage, the aneurism is described as filled with well-formed recent clot, which also extended into the popliteal artery and to some distance below its bifurcation.

In Mr. Heath's case (No. 61) the aneurism was found "filled with coagulated blood."

In Mr. Clutton's case (No. 60) of femoral aneurism the sac was almost

entirely "occupied by a recent (post-mortem) clot, very little indeed being decolorised in the peripheral part of the sac."

In Mr. Pemberton's case (No. 53) "the aneurism was filled with clot, some being of the character of laminated fibrin, but the bulk, recent coagulum. The artery was filled with recent clot, and for a distance of one to two inches."

In Mr. Rivington's case (No. 68) of false aneurism, the sac was found filled with recent coagulum. Above the false aneurism the artery was filled with partially decolorised fibrin, and the clot extended into the popliteal artery; the decolorised portion of the clot occupied the popliteal artery.

In Dr. Reid's case (No. 1), in which death occurred some months after the cure of the aneurism, the centre of the sac and the part next the vessel were filled with amorphous, non-laminated, coffee-coloured substance, with no appearance of organisation or vascularisation; opposite the mouth of the sac were several layers of laminated fibrin; the artery was occluded by fibrous tissue.

In Mr. Wagstaffe's case (No. 2), also examined after cure was established, the artery was found to be blocked above and below the aneurism, which was plugged with blood-clot, the outer part of which was organised; there was no appearance of laminated fibrin.

How does this coagulation of the blood effect the permanent cure of the aneurism? In itself it is but the preliminary step to that result, for the clot is soft, little resistant, and, as we have mentioned above, unstable; and it is only by some change in it, or to which its formation leads, that the permanent cure is attained. Only two of the cases of cure have been afterwards examined and the condition published. These are the first two cases thus treated, Nos. 1 and 2. Case 1, Dr. Reid's, died from bronchitis and other mischief unconnected with his aneurism, nine months after the aneurism was treated; and at the autopsy it was found that the popliteal artery was occluded for two and a half inches by fibrous tissue, and that the aneurism still existed as a solid tumour, the sac being lined opposite the opening in the arterial wall by several layers of laminated fibrin; and the rest of the cavity—the larger portion—was filled with amorphous, non-laminated, coffee-coloured substance, with no appearance of organisation or vascularisation. Case 2, Mr. Wagstaffe's, died from rupture of an aortic aneurism rather more than four months after the cure of the popliteal aneurism, and the following is Mr. Wagstaffe's description of the parts, quoted from the *Path. Soc. Trans.*, vol. xxix.: "The popliteal aneurism was completely filled with old clot, decolorised in the greater part of its extent. Its length was two inches and its width one inch, and the plugging extended to within a short distance of a large branch both above and below. The outer parts of the clot were evidently organised, and it seemed that only a portion was not organised. The artery had apparently given way on the outer side, and upon careful examination the coats of the

vessel could be traced over the aneurism with varying uniformity. The middle coat could be distinctly seen above and below, and it seemed that the blood had burst through it on the outer side, for some indication of a continuity of the middle coat could be traced throughout along the inner side, though the outer coat had been much thickened here as well as on the other aspect of the aneurism. When examined microscopically, the outer area was seen to be composed of well-marked fibroid tissue, the meshes of which were occupied by vessels and scattered blood-discs. The central portion consisted of blood corpuscles and numerous other corpuscles of about the same size, which stained readily with logwood." It is not stated precisely of what nature the tissue plugging the artery was, but from the language quoted and from a careful examination of the specimen itself, there appears to be no room for doubt that it is fibro-cellular tissue. As to the aneurism itself, it is clear that the central part of the cavity was still filled with old and altered but not organised blood-clot, while surrounding this was fibroid tissue; but whether that was mere thickening of the sac of the aneurism, or the result of the organisation of an outer zone of clot, it appears to be impossible to say.

The main fact taught by these specimens in regard to the mode of permanent cure of an aneurism is, that the blood-clot in the artery becomes replaced by a living mass of fibro-cellular tissue, while most or all of that in the aneurism becomes dried, discoloured, and partly absorbed but not organised. How is this difference in the destiny of two parts of a continuous and homogeneous blood-clot to be accounted for? If no other evidence were at hand, this fact alone would demonstrate that the changes a clot forming in the living body undergo depend not so much upon the clot itself as upon the condition of the tissue in which it lies. This is well illustrated by what we know of the fate of a thrombus in a healthy artery as compared with that of a similar thrombus in an artery the seat of advanced atheroma—the one organises into fibrous tissue, the latter fails to organise at all. Whatever view may be held as to the exact part the constituents of the clot play in its organisation, whether the white corpuscles of the clot be regarded as taking an active share in the cell development, or the clot be regarded merely as a suitable nidus for organising lymph (which seems more probable), it is equally clear that the process depends upon the condition of the tissues surrounding the clot. If these tissues are healthy and vascular, plastic lymph is readily effused and infiltrated into the clot; but if they are diseased, and especially if they are non-vascular or devoid of all active vital properties, the lymph is not effused, the clot is not organised. It is, however, quite consistent with this view also to hold that the nature of the clot itself may exert some influence upon the process of its organisation. But the blood-clot only organises through the agency of lymph effused from the surrounding tissues.

Applying these considerations to the case in point—to a clot filling an

aneurism and the adjacent part of the artery—it is evident that the nutritive conditions of the sac and the artery may be and usually are different. The artery is entirely composed of living tissue, and it is only the extreme degrees of atheromatous disease that are incompatible with the due organisation of a thrombus; provided that an arterial thrombus be undisturbed, and not septic, and that destructive inflammation or gangrene do not attack the wound, it is of extreme rarity that it does not become organised. But in the sac-wall we have quite other conditions. Very often there is a more or less thick lining of laminated fibrin—lifeless, hard, resistant matter, with no power of effusing lymph, but considerable power of preventing its transudation. The sac-wall proper may be of various composition, but is generally formed either of the outer coat of the artery, or of condensed fibrous tissue; and in either case, from the stretching to which it is subjected, its supply of blood is interfered with; so that the sac of an aneurism is by no means adapted for the effusion of plastic lymph into a clot within it. Hence, under favourable circumstances, the thrombus in the artery organises into fibro-cellular tissue, while the clot in the aneurism does not. In other words, *the permanent cure of the aneurism is brought about by organisation of the thrombus in the artery rather than by any change in the aneurism itself, the clot in the aneurism being of use mainly as a means of securing a thrombus in the artery.* Of course, so soon as the artery is obstructed, the tumour springing from it ceases to be an aneurism proper. Strongly supporting this view is the circumstance that, as shown in the Table of Cases, in every instance of popliteal aneurism where the state of the vessels about the knee-joint after the cure is mentioned, it is stated that the anastomosing vessels were enlarged, and evidently carried on the circulation in place of the plugged popliteal trunk: in ten cases this is distinctly stated. No case of cure is recorded of which it is stated, or can be inferred from the report, that the aneurism was occluded without coincident obliteration of the artery. The clot in the aneurism does not organise unless immediately surrounded by vascular tissues; where fibrin in any quantity intervenes, its organisation is delayed or entirely prevented, the clot then shrinks by its inherent power of contractility, the serum is absorbed, and the dried remains undergo absorption or remain behind as a soft friable mass.

The process of cure by this treatment depends, then, first, upon clotting of the blood, which commences in the aneurism, and spreads into the artery; and, secondly, upon the organisation of the clot in the artery. The clotting of the blood, which is an act of death, commences in the aneurism because its walls are deficient in some as yet not understood vital power; but the organisation of the clot in the aneurism often fails for a closely allied reason, and occurs in the artery because its walls are vascular and their vitality is not seriously interfered with.

CHAPTER III.

THE CAUSES OF FAILURE.

If the explanation of the way in which success is obtained under this mode of treating aneurisms be correct, it is clear that want of success must be due to failure of one or other of the two processes which we have seen to be essential—either the blood does not coagulate, or the coagulum formed does not organise, and permanently occlude the aneurism. An examination of those cases of failure where sufficient details are given to permit of an opinion being formed, shows that they have all arisen from one or other of these causes. And, indeed, it must be so.

Each one of these causes of failure may be broken up into two, which are worthy of some attention. Thus the blood may fail to coagulate either because it is not left stagnant at all, or only for an insufficient time, or because of some special vital relation of the blood and the sac, or character of the blood itself, preventing such coagulation; or the clotting, commencing in the aneurism, may fail to extend into and occlude the artery; for, as we have seen, it is the thrombus in the artery that is the essential and important part of the clot. Some cases have not succeeded because the surgeon either has not appreciated the principles underlying this treatment, or has failed in its practical application; and has failed to obtain stasis in the aneurism, or has not kept it up for a sufficiently long time. Case 19 illustrates the influence of "time" very well, for on the first application of the bandage for an hour, the blood did not clot, but when four days later the bandage was kept on for two consecutive hours the blood clotted. The time necessary to obtain coagulation varies much in different cases. In some patients a firm clot has formed in less than an hour, in others only in the third hour of complete stasis (*vide* page 32). Time is required not merely to start coagulation, but to allow of the formation of the thrombus in the artery. I would repeat that the cure of the aneurism depends not on its own occlusion, but on the formation and subsequent organisation of the clot in the artery. As we are not able to speak with precision of the character of the sac, or blood, which favours or causes coagulation of the stagnant blood, so we can only suggest circumstances that may serve to explain the non-coagulation of the blood in some cases. Provisionally, we may mention smoothness of the inner surface of the sac, its freedom from laminated fibrin, and the circulation of pure blood through the tissues of the sac itself. An endothelial lining to the sac would no doubt account for this result, but it can hardly be held that in any aneurism so large as those contained in the Table—variously described as "as large as an orange," "a large fusiform tumour," "as large as a pigeon's egg," "filled the ham," "size of a small egg," —the endothelial lining was perfect. As I have already stated, the quality of the

blood that leads to the use of the terms "plastic" and "aplastic," hardly yet admits of more definite description, but there is evidence that diseased states and some drugs do increase or diminish the readiness and completeness with which blood coagulates, and it is sufficient to make the surgeon anxious to have more light thrown on this matter by the physiologist and pathologist, so that he may be able to favour the coagulation of the blood in aneurisms thus treated by the use of appropriate means before or at the moment of application of the elastic bandage.

The other cause of failure has been the disappearance of the clot soon after removal of the elastic bandage, or a failure in the organisation of the clot and permanent occlusion of the aneurism. Among others, Cases 33, 37, 41, 62, illustrate this occurrence. For in the account of these cases it is stated that on the removal of the elastic bandage the aneurism was found to be solid and pulseless, but that pulsation soon returned to the same extent as formerly. This failure of the clot to organise may arise from two causes—(1) the clot may be disintegrated by the force of the blood before organisation can occur, or (2) the parts may be in such an advanced state of disease that organisation is impossible. There is no evidence that in any case at present recorded the latter has been the case, so that we must confine our attention to the disintegration of the clot by the blood current.

There are several important points to be noted in connection with the disintegration of the clot. The first is that it occurs so often; the next, that in these cases the clot disappears without leading to embolism. This suggests most interesting inquiries as to the precise change in the clot. Is the fibrin re-dissolved, or merely truly disintegrated and broken up into excessively fine particles? Are the corpuscles injured by their temporary detention in the clot, and so rendered unfit to resume their function in the vital fluid? Or do they at once resume that function? The conditions are such that it is impossible to obtain direct and positive answers to these questions, but collateral evidence, as well as the close observance of the cases, will enable us to arrive at approximate solutions of the problems. Thus we know that blood which has clotted outside the body never again recurs to its former state; but if exposed to air and allowed to decompose, only becomes fluid as a result and concomitant of decomposition. Fibrin outside the body does not show any tendency to assume a liquid condition. Nor does it exist as a liquid in living blood, but as a compound of other bodies. When formed outside the body, it is found to be soluble with difficulty in solutions of hydrochloric acid 1-5 per cent.; and with greater facility in dilute solutions of ammonia and other alkalies, especially when heated, being then converted into alkali albumen. There is, then, in the alkali of the blood a solvent of the fibrin. When many corpuscles are returned to the circulation as useless and effete bodies, certain effects follow—viz., a petechial eruption on the skin, and an increased excretion

of the hæmatin in the form of biliary and urinary pigment. No observations on these points in the cases in question are recorded; but as most of the patients were in hospital at the time, it is probable that a petechial eruption would have been at once noticed. Excess of uro-hæmatin, however, is not necessarily associated with a dark colour of the urine; indeed, it may be found in very pale urine, and may be overlooked unless specially sought; but it is to be easily detected by boiling the urine and then adding a small quantity of nitric acid, when a deep crimson colour is produced. This test should certainly be employed in any case where the clot suddenly disappears.

Still more important in this connection are the results obtained by Köhler.* This observer drew two ounces of blood from the femoral artery of a dog, allowed it to coagulate, and then after about twenty minutes broke up the clot with his fingers, and introduced the carefully strained blood into the femoral artery of the opposite side. Within ten minutes the animal became collapsed, with irregular action of the heart and difficult respiration; liquid mucous and then bloody stools were passed in rapid succession, and the animal died in a state of complete prostration. These remarkable effects are supposed to be due to the action on the blood of the fibrin ferment, set free from the disintegrated white corpuscles, which is introduced with the clear filtrate. Dr. Sanderson further shows that this disintegration of leucocytes occurs as an apparently essential part of the process of coagulation of blood. In no one of the cases before us were symptoms in any way approaching this noticed. Two reasons for this suggest themselves—the one is that in the cases of disintegrating clot the product of disintegration was slowly and gradually introduced into the blood, which may either have the property of destroying it in small quantity, or of re-absorbing it into the white corpuscles: the second is that in the idiopathic cases the blood-clot was at no time removed from contact with living tissues, and was not exposed to violence such as would destroy red corpuscles.† The balance of evidence then appears to support the view that the fibrin is dissolved by the alkaline blood in the form of alkali albumen, and that the red corpuscles pass into the blood as living constituents to resume their special function, and that any fibrin ferment set free by the destruction of corpuscles is either taken up at once by active corpuscles, or else excreted or altered in composition and function as quickly as introduced into the blood. These cases of aneurism, where consolidation has been only temporary, have afforded the clearest and most convincing evidence of the possibility of the "resolution" of blood-clot, but they are by no means the only examples of such a process. In some cases of phlebitis or venous thrombosis it is easy to demonstrate that the once blocked

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* See lecture by Dr. J. B. Sanderson on the Infective Processes of Disease: *Brit. Med. Journ.*, 1878, i. 45.

† The most recent experiments show that the red corpuscles are far more important factors in coagulation of the blood than has been hitherto held.

vein becomes again pervious to the blood. It has been occasionally noticed in aneurisms treated by galvano-puncture—the clot formed round an electrode quickly vanishing without any constitutional disturbance. If it could be clearly demonstrated that the blood does resume its vital properties, this fact would to some extent modify the view that coagulation is to be regarded as the first act of death of the blood.

Next arises the question how this disintegration is caused. From all that we know of the behaviour of coagulum out of the body we may fairly assert that the clot does not spontaneously liquefy, but only disappears as the result of some external force. This can hardly be any condition of the aneurismal sac or artery wall, but is probably the impulse and solvent power of the circulating blood, for it is found that pulsation in the aneurism always precedes the complete disappearance of the clot.

But in many of the successful cases slight pulsation in the aneurism has been noticed on removal of the elastic bandage (see Cases 5, 6, 10, 21, 22), which, after lasting for a short time, finally disappeared. This can only be produced by blood continuing to circulate through the artery alone or the artery and aneurism. I believe the explanation of it lies in the fact that blood-clot of necessity shrinks and expresses the serum contained in its meshes. And so if at first the clot completely fill the aneurism and adjacent portion of artery, by this necessary contraction it will soon shrink away from the wall of the cavity, and obviously that part of the clot which lies in the artery (the part formed latest) will adhere to that in the aneurism and will shrink from the opposite side of the vessel; the interval between the clot and the artery will be filled with the expressed serum, but when the elastic bandage is removed this serum will mix with the blood, and the blood stream will occupy its place and impart pulsation to the whole vessel and aneurism. If the blood flow past the clot with undiminished force and rapidity, it may wash away or disintegrate the thrombus; but if the flow of blood be only slow and with slight force, fresh separation of fibrin occurs until the original clot is again built up to its former size and the vessel is securely occluded and all pulsation lost. But this necessary shrinking of the clot exposes it to its one great peril—the disintegrating influence of flowing blood. In Case 21 no pulsation was observed when the bandage was first removed, but occurred an hour later, showing conclusively that it resulted from some *change* in the parts; and that change was no doubt shrinking of the clot.

These considerations are of great practical importance, as they suggest the treatment necessary to ensure success. After removal of the elastic bandage the shrinking clot must be allowed to grow by fresh deposits on its surface, and for this a gentle, even trickle of blood over its surface is best adapted. And again, the soft recent clot must be protected from the strong impulse of the unimpeded flow of blood along main arteries. For these reasons some

form of compression of the main artery above the aneurism must be kept up for some hours after the formation of the clot has been secured by the use of the elastic bandage. The surgeon must be as careful to preserve and protect the clot when formed as he is to secure its formation.

CHAPTER IV.

A CONSIDERATION OF THE OBJECTIONS THAT HAVE BEEN RAISED TO THIS METHOD OF TREATMENT.

This plan of treating aneurisms is not free from certain disadvantages, and objections have been raised to its employment which require to be carefully weighed before it is generally adopted. These alleged dangers and drawbacks are as follows:—

1. The increase of the general arterial tension caused by the application of the elastic bandage.
2. The fall of the general arterial tension on removing the bandage, owing to the paralytic dilatation of the vessels of the affected limb.
3. The risk of causing gangrene.
4. The danger of exciting renal disease.
5. The pain it produces.
6. The danger of injury to nerves by the prolonged compression to which they are exposed.
7. The danger of causing rupture of the aneurism.
8. Its frequent failure.

We will consider each of these separately. Broca's objection to the formation of a blood-clot in an aneurism, as liable to cause suppuration, is not included in the list, as it rested upon a misconception; the suppuration he witnessed being due to the methods of obtaining the clotting of the blood in the sac, and not to the mere presence of the clot. The large number of cases in which this particular plan of treatment has been carried out without one case of even threatened suppuration shows that in itself the coagulation of blood in an aneurism does not set up inflammation in and around the sac.

1. *It has been alleged that the application of Esmarch's elastic bandage to a limb increases the general arterial tension.* Bruns* has shown that the effect of the bandage is to express into the general systemic vessels 70 per cent. of the blood in the part to which it is applied. The quantity of blood in the body

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* Virchow's "Archives," lxvi.

is estimated at 1-13th of the total weight, that in the skeletal muscles being 1-4th of the whole; and in a case of popliteal aneurism, for which the bandage is applied from the toes to the middle of the thigh, we may estimate the extra quantity of blood thrown into the vessels of the rest of the body as about 1-14th of the whole, or in a man weighing 14 stone, about 1 lb. of blood.

In experiments with the plethysmograph Dr. Mahomed* found that when Esmarch's bandage was applied to one arm the volume of the other arm increased in size, because of the increase in the quantity of blood received by it. He thought "it was obvious that the blood pressed out of the limb must be distributed among the rest of the vessels of the body, materially increasing their tension, and in a sudden manner. If general arterial disease were present, this sudden increase in the amount of blood in the cerebral vessels might lead to ill results." An increased quantity of blood in the general circulation is, however, not necessarily accompanied by an increase in the vascular tension; for the vessels are normally in a state of tonic contraction; they are never filled out with blood. It is stated that all the blood in the body can be contained in the abdominal vessels alone; and the daily experience at *post-mortem* examinations, where the arteries are all found empty, and the veins only partially filled, shows conclusively that to maintain the full condition of the vessels during life considerable contraction of their lumen is necessary. This being so, an additional quantity of blood can be accommodated by lessening this contraction of the vessels. In other words, the general effect of the application of Esmarch's bandage may be to increase either the size or the tension of the vessels. Which is the usual effect? Dr. Mahomed, in the speech already quoted, does not mention any observations on this point. Dr. Weir† says that in one of his cases (Table, No. 51) where the bandage was applied from toes to groin, the sphygmograph showed a marked rise in the general arterial tension ten minutes after the bandage was applied; he does not publish his pulse tracings.

In the *Medical Times and Gazette* of August 30, 1873, Dr. Mahomed refers to a case in which he found that compression of the abdominal aorta instantly caused the radial pulse to become very dicrotic, and he publishes the sphygmographic tracings taken before and during the pressure. Dr. Mahomed states that the dicrotism was caused by the increased tension in the radial artery bringing the elasticity of the vessel more into play. It is difficult to accept this explanation, which is directly opposed to the general teaching that dicrotism is an effect of decreased tension. It may be that the pressure on the aorta caused some direct effect upon the abdominal sympathetic, which induced great dilatation of the abdominal vessels, and so a fall of arterial pressure generally. I would, how-

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* *Lancet*, 1880, ii. 880. † *Amer. Jour. Med. Sci.*, 1879.

ever, bring forward this instance of compression of the aorta to prove that, at any rate in some cases, such compression as is exerted by Esmarch's bandage causes diminished, and not increased, arterial tension over the rest of the body.

I have made some observations on this point on adult male patients in Westminster Hospital suffering from slight injuries or chronic diseases. Having obtained a tracing of the radial pulse with the man lying down, I have then applied Esmarch's bandage firmly from the toes to the middle or top of the thigh, and wound the tubing tightly round the top turn, and have taken another tracing at once, or after an interval of ten minutes; on removing the tube and bandage, a third tracing has been taken when the limb has become suffused and red. In one case the tracing showed distinct fall in arterial tension ten minutes after the application of the bandage to the lower limb; in another a very slight fall was recorded; in two no change could be detected. (See page 44.)

While, then, it is impossible to deny that this alleged increase of arterial tension may be produced in some cases, what evidence there is on the point rather tends to show that during the application of the elastic bandage the arterial pressure may fall.

Very serious results have been attributed to this supposed increased pressure—viz., the development of internal aneurism, and the sudden increase in size and rupture of an internal aneurism. Two illustrations of each result are to be found in the table of cases. In Case 2, a popliteal aneurism was cured, but the man died nine months subsequently from rupture of a small aortic aneurism. In Case 17, a popliteal aneurism was cured, but an innominate aneurism subsequently developed and proved fatal. In these cases it is only a conjecture that the fatal aneurisms were formed during the cure of the others. In Case 60, death occurred suddenly from rupture of an aortic aneurism fifty days after the application of Esmarch's bandage for a femoral aneurism. In Case 61, an aneurism of the aorta, close above the part of that vessel compressed by the pad of "Lister's tourniquet" in the treatment of a femoral aneurism, ruptured and caused sudden death. It is to be particularly observed that neither of these aneurisms burst while the bandage was applied, and when, according to the theory in question, the pressure in them would be at its maximum. These four cases are conclusive evidence, however, that before resorting to this treatment, a most careful examination of all the other arteries of the body should be made, to find out if other aneurisms exist; and only in the absence of any signs of such should Dr. Reid's treatment be adopted. As we have seen, there is no occasion to press the blood out of the limb below the aneurism; and if this is not done, but little (if any) effect can possibly be produced upon the tension in the general circulation by this procedure.

2. *The second objection to this treatment is that the fall of the general arterial tension, after the removal of the elastic bandage, may cause syncope.* The anæmia caused by the elastic compression is followed by hyperæmia on its

removal. The previously pallid skin becomes suffused. When the elastic bandage is used in operations, the bleeding from small vessels is always more abundant on its removal than if it had not been employed. This dilatation of the vessels is from vaso-motor paralysis, due to the anæmia of the muscular fibres of the vessels themselves, and of the nerves governing them. The effect is in this respect like that produced by the application of Junod's boot, or by section of the sympathetic of the limb.

The effect upon the general circulation is comparable to that of hæmorrhage —the patient, as it were, bleeds into the affected limb. And it has been feared that this might cause a serious or even dangerous fall in the general blood pressure. Remembering, however, the contractile power of the arteries, which adapts them to the bulk of blood in the body, this effect would seem not to follow as a matter of course. In the experiments alluded to above, I have not been able to obtain evidence in pulse tracings of any fall in the blood pressure, but as the bandage had only been applied about ten minutes in each case, the subsequent engorgement of the limb was not extreme. There are two circumstances, however, which, in most cases obviate this objection. The first is, that in all successful cases the main artery is plugged with blood-clot opposite the aneurism; and this affords an obstacle to the filling out of the vessels below. The second is that in all cases where the stagnation of the blood has led to its coagulation, it is necessary to compress the artery above for some hours to protect the sac and clot. It is only in the absence of the thrombosis, and under neglect of this necessary precaution, that such effects in the general system need be feared. The force of the objection lies in this, that it shows that in cases where the blood does not clot—cases of failure at the first step—on removal of the elastic bandage, some means should be adopted to lessen the flow of blood into the limb until the vessels have recovered their tone.

Dr. Weir's fatal case (No. 30) perhaps affords some support to this objection. The elastic compression of the lower limb was kept up for six hours fifty minutes, and Signoroni's tourniquet was applied for half an hour longer. The aneurism was then solid, and free from pulsation. A 7lb. shot bag was laid over the artery at Poupart's ligament, and the man was left for the night. Next morning his pulse was nearly absent at the wrist, and very weak and irregular in the femoral artery (I conclude that the shot bag was removed), and twenty-seven hours after the discontinuance of the compression, the man died from collapse. At the autopsy there was found "advanced fibroid phthisis in both lungs, an atheromatous aorta, and, microscopically, a distinctly fatty degeneration of the muscular fibres of the heart, more particularly observed in the right than in the left ventricle. The other organs, brain, liver, and spleen, were normal. The kidneys were intensely congested, but otherwise normal."*

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* "Archives of Medicine," April, 1880.

The man is described as being "in good condition" before the compression was commenced, and also when left for the night. The cardiac failure is, however, probably connected with the treatment, and the feasible explanation is that the engorgement of the vessels of the lower limb, added to the atheroma of the aorta, put too severe a strain upon a heart unable, on account of degeneration, to respond to it. The case affords further evidence that this treatment is not to be lightly or empirically undertaken, but that a careful examination of the whole vascular system should be an invariable preliminary step.

3. *Another objection that has been urged against this treatment is that its local effects are such as tend to cause gangrene.* As, if valid, this would be a fatal objection, we will consider it somewhat fully. And first, let us examine the evidence in its support. It consists of two cases in which gangrene has followed this use of the bandage, and of observations of certain effects of the bandage in other dissected specimens.

The first case of gangrene is one that occurred in Mr. Bryant's practice at Guy's Hospital (No. 37) in 1877, and is thus described in his "Practice of Surgery," 3rd edition, vol. i. p. 447. "The case was that of a man, aged 45, who was admitted into Guy's under my care in March, 1877, with a popliteal aneurism, which was increasing so rapidly that active treatment was called for. The man could bear neither digital nor instrumental pressure upon the afferent artery. I consequently applied the elastic bandage to the limb below the aneurism, using moderate pressure, allowed the aneurism to fill with blood, and then so compressed the thigh above the sac as to entirely check all pulsation in it, these three being apparently the essential points to observe. . . . . The pressure was maintained for three hours consecutively, ... but when the bandage was removed the aneurism was decidedly harder, although pulsation still existed in it. Four days later all clots seemed to have disappeared, and as the aneurism was as big as ever the elastic bandage was again applied, ... and continued for three hours, and at the end little had been gained from it. A fortnight was then allowed to elapse to allow the parts thoroughly to recover themselves, when a carbolized catgut ligature was applied to the artery, and within one week this wound had completely healed by immediate union. . . . . The foot, however, soon became the seat of anæmic gangrene, and a fortnight after the application of the ligature was amputated. . . . . In this case I am disposed to attribute the gangrene to the employment of the elastic bandage, and fear that from its two applications many of the small arterial branches that would have carried on the circulation through the foot, after the ligature of the femoral, had become blocked, and that, as a consequence, gangrene followed." In the "Transactions of the International Medical Congress, 1881," vol. ii. p. 221, referring to this case, Mr. Bryant adds: "At the amputation, which was performed below the knee, no artery required torsion or a ligature, as all were obstructed."

The other case is one of Mr. Pemberton's, recorded by him in the "Transactions of the International Medical Congress, 1881," vol. ii. p. 222. "The patient, a man 45 years of age, the subject of popliteal aneurism for twelve months, was treated early in 1878 in the Birmingham Hospital. The bandage was applied standing, so as to distend the sac, and above all was cast the elastic tourniquet. At the end of an hour, when these were removed, pulsation had almost ceased, but the aspect of the aneurism was alarmingly livid, and ecchymoses were abundant on the tense integument. For twenty hours subsequently pressure was made at the arch, and the pulsation altogether ceased. Gangrene from the toes upwards—threatening from the first—was now apparent, and it was rapidly spreading; amputation through the thigh was performed, but this failed to save the patient, who sank a few days afterwards. The aneurismal sac was found unruptured, but there were extensive extravasations into the cellular tissue, and capillary hæmorrhages generally around. The femoral (popliteal?) vein was obliterated by the growth of the aneurism."

In Mr. Pemberton's case the gangrene was undoubtedly caused by the obliteration of the popliteal vein, and had nothing whatever to do with the particular mode of treatment employed. Had any other form of compression or the ligature been employed a similar result would have followed, and it is clear that it did not depend upon any impediment to the establishment of the anastomotic circulation supposed to be caused by rupture of small vessels, but solely upon obstruction to the venous return. This case, therefore, affords no evidence that the treatment is attended with any special risk of gangrene.

Mr. Bryant's case is more difficult to explain, as the evidence is incomplete; for the limb was amputated below the ham, and the condition of the aneurism, artery, and vein was not ascertained, only conjectured. The facts known may be summarised thus:—The aneurism was rapidly increasing, and Esmarch's bandage was applied for three hours, after which the sac was partially consolidated —it is not stated that any subsequent compression was employed—and after four days all the clot had disappeared; the bandage was again applied for three hours, but without producing any change in the aneurism: after a fortnight the femoral artery was ligatured, anæmic gangrene of the leg ensued, for which amputation was performed a fortnight after the ligature of the vessel, and all the arteries in the flaps were "obstructed," none requiring ligature or torsion. The theory that has been advanced to explain these occurrences is that while the bandage was applied many of the small vessels in the popliteal space were ruptured, and thus were unable to carry on the anastomotic circulation after the ligature of the main artery. There is distinct evidence that such capillary rupture takes place, but this theory is not supported by all the facts of this case. In the fortnight that elapsed between the elastic compression and the ligature, these minute injuries would be in great measure, if not entirely, repaired, and Mr. Bryant speaks of having waited "to allow the parts

thoroughly to recover themselves;" and if there had been difficulty in carrying on the anastomotic circulation, the tibial arteries would have been found empty at the amputation, whereas both of these trunks, and all the branches of artery cut across, were found "obstructed," showing clearly that blood had been able to get into them. Surely the plain reading of this case is that the gangrene was caused by arterial thrombosis, and not by any imperfection of the anastomotic circulation! Such obstruction of all the arteries of the part we know to be an efficient cause of anæmic gangrene, and it is unnecessary, therefore, to attribute it to another cause which can only be surmised and not demonstrated. What, then, was the cause of the thrombosis? Can it be that the bandage produced some effect on the arteries which led to the coagulation of the blood a fortnight later? Probably not. For it is stated that while the first application of the bandage was followed by clotting in the sac, the second, which was carried out in the same manner and for the same length of time, was not successful in producing any coagulum. If the bandage could so affect the arteries as to lead to coagulation of the *flowing blood* after the lapse of a fortnight, surely it would have caused clotting of the *stagnant* blood only four days subsequently! Such reasoning from probabilities is of no value when opposed to established facts, but in their absence—as in the case before us—appears warranted.

Capillary hæmorrhage, however, may occur as a result of this treatment. In the "New York Archives of Medicine," 1880, vol. iii. p. 207, Dr. Weir records a case of a man aged 28, with popliteal aneurism, for which the elastic bandage was applied for two hours and a half, and three days later for four hours. The leg became cold and threatened to become gangrenous, and the man died in twenty-seven hours. At the autopsy, minute capillary hæmorrhages were seen in the superficial, but especially in the deeper, parts. This patient was proved to have old phthisis and a fatty heart, and the kidneys were intensely congested. In Mr. Pemberton's case (No. 53) "there were extensive extravasations into the cellular tissue, and capillary ecchymosis generally around" the sac of the aneurism. In his speech at the International Congress (*loc. cit.*) Mr. Bryant said, "I applied the bandage for an hour, . . . on the day following its application small capillary ecchymoses, the size of split peas, were seen in the skin over the tumour . . . . In the second case I applied the bandage tightly on December 6th for thirty, and subsequently more loosely, for eighty minutes, and on December 7th ecchymoses were seen in the skin over the sac, as in the former case." Other surgeons have noticed the same fact—ecchymosis of the skin over the tumour; and Mr. Pemberton's and Dr. Weir's cases warrant the conclusion that in such cases the deeper parts are even more affected in the same manner. Both of Mr. Bryant's cases were cured by ligature of the femoral artery, even although in the latter case that operation was performed on Dec. 10th, before the capillary lesions could have been repaired. And so, out of twenty cases in which, the bandage having proved

unsuccessful, the artery above has been ligatured, seventeen have been cured without accident; one, as we have seen, had gangrene (No. 37); one died from blood poisoning (No. 41); and one case of diffuse aneurism submitted to amputation (No. 64). So that although this capillary ecchymosis undoubtedly occurs to a greater or less degree in many, if not in all, cases, there is no evidence that it has ever interfered with the due establishment of the anastomotic circulation.

The capillary rupture is probably caused by the distension of the vessels produced when the bandage is applied to the limb above the aneurism, and it might be prevented by supporting the part by a bandage so applied that it does not empty the aneurismal sac. The other possible explanation is that the small vessels, being paralysed by the prolonged stasis in the *vasa vasorum*, lose their power of resisting the blood-pressure, and are ruptured when the greater strain of the anastomotic circulation is thrown upon them. Were this the explanation, however, I think the ecchymosis would not be so limited to the part unsupported by the bandage.

Mr. Pemberton has stated (*loc. cit.*), "that the entire tendency of this mode of treatment is to leave undeveloped the collateral circulation—which constitutes the basis of Hunter's treatment by ligature, and that of the Dublin School by pressure." This may appear to be the case if we regard solely the condition of the parts while the bandage is applied, when all circulation collateral and direct is stopped; but, as I have attempted to show, this is but the first step in the process of cure, and its sole aim is to obtain a blood-clot in the aneurism and artery, or, in other words, a blocking of the artery at the seat of the aneurism. When the bandage is removed the collateral circulation is established as in any other treatment or affection blocking up an arterial trunk. No treatment "develops" a collateral circulation—it is the work of unaided Nature, and therefore no treatment can be rightly spoken of as leaving it "undeveloped." But in one respect this mode of treatment specially aids Nature in her work. For, as already mentioned, after the removal of the elastic compression the vessels of the part are from vaso-motor paralysis passively dilated, and thus a freer passage than normal is offered for the blood through the smaller anastomosing channels. As a matter of fact, the collateral circulation has been several times noted to be readily established; and, with the exception of the cases I have already discussed, no mention of difficulty in this particular appears in any of the published reports of cases.

It appears, then, that there is no direct or positive evidence to support the assertion that this treatment has caused, or is liable to cause, gangrene; but as the capillary rupture which attends the application of the bandage in the usual mode can do no good, and may possibly produce harm, it is desirable to use some means to lessen or prevent that accident.

4. *Mr. Bryant has suggested that there may be a risk of this mode of treatment*

setting up albuminuria, and he adduces two facts in support of such a view. I quote from his speech as reported in the "International Medical Congress Transactions," vol. ii. p. 221. "In the second case, Elias W., aged 42, I applied the bandage tightly on December 6, 1880, for thirty, and subsequently more loosely, for eighty minutes, with no good results. . . . . On December 10 the femoral artery was ligatured, the wound rapidly healed, and the aneurism became cured. In a month, however, acute albuminuria set in, and death on February 17, sixty-nine days after the operation, and thirty-seven after the first appearance of the albumen. At the date of the operation the urine was quite healthy. . . . . In the fatal case of Dr. Weir, the kidneys after death were found markedly congested, and in one of my three cases acute albuminuria followed the cure thirty-seven days after the application of the bandage. These may be mere coincidences, but they are worthy of notice." As we have already seen, the cause of death in Dr. Weir's case (No. 30) was cardiac failure, and as a consequence there was general visceral congestion, in which the kidneys shared. It is hardly possible to admit that the use of the elastic bandage, and the subsequent albuminuria in Mr. Bryant's case, was anything but a coincidence. For it is recorded that the bandage having been used on December 7, the urine was quite healthy on December 10, when the artery was ligatured; indeed, it was only more than a month later that the albuminuria, which was so soon fatal, supervened. Obviously, the effect upon the kidneys of the application of the bandage to the leg was most intense at the time, and could not have been latent for more than a month, like some zymotic poison, then to exert its baneful influence. There are many other possible and likely explanations of the renal affection, and even had they all been excluded —as they have not—it would have been difficult, if not impossible, to accept this interpretation of the events.

5. *The application of the elastic bandage is so painful* that only the most phlegmatic or the most heroic patients can bear it unless rendered partially or wholly unconscious by subcutaneous injection of morphia or inhalation of ether. Dr. Murray laid stress upon the fact that anæsthesia during the whole of the active treatment formed an essential part of the "rapid method." The bandage has to be applied for from three quarters of an hour to three hours, and there can be no difficulty in keeping the patient insensible during that time. In many cases, however, morphia has been used instead of ether or chloroform. Against this practice is the fact that the anæsthesia is less perfect, and in some cases has been found to be hardly sufficient; but in favour of it, possibly, is the consideration that while ether stimulates the heart and increases the arterial tension, morphia has the contrary effect, and even lessens the tension. If, then, the bandage has any tendency to increase arterial tension, and is in some measure dangerous on that account, it would seem that morphia is safer than ether to dull the sensation of pain the bandage causes. It is to be noted, how-

ever, that in neither of the three cases (2, 17, 61) in which other aneurisms developed and even proved fatal subsequently to cure of a first aneurism by this method, was ether used. Case 2 had $\frac{1}{3}$ gr. of morphia hypodermically. In Dr. Weir's case (No. 30), which died from collapse, ether was not used, but $\frac{1}{4}$ gr. of morphia was administered. The actual clinical evidence before us does not warrant, then, the fear that the use of ether may increase any ill effect the bandage may have on the general circulation. (Vide p. 42.)

6. Apart from the pain, *is there not some fear that the prolonged compression of the nerves by the bandage or cord may be permanently injurious?* In no one of the more than seventy cases of aneurism thus treated has any sign of nerve injury been recorded, and therefore we may presume the nerves escaped injury altogether. For other purposes the elastic bandage has been applied for very long periods without causing motor or sensory paralysis. Thus E. Mason* applied it to the common femoral artery for eighteen hours; and Hoxie† states that he has applied it continuously for thirty-three hours forty minutes.

On the other hand, in a case of recurrent hæmorrhage from a wound of the thenar eminence, the elastic bandage was applied as high as the middle of the arm for fourteen consecutive hours, and its removal was followed by intense swelling, redness, and paralysis of all the parts beneath the bandage, which, however, ultimately passed off.‡ During an operation on a man for necrosis of the humerus and ulna, the bandage and the elastic tubing (which had been put on above the highest turn of the elastic bandage) was retained for three-quarters of an hour. Afterwards there was temporary paralysis of the median and ulnar nerves.§ Langenbeck has had three cases of paralysis after using the bandage and tubing. Two were cases of operation for pseudarthrosis of the humerus, and in each the branches of the median nerve were paralysed for a fortnight. The third case was after an operation for central necrosis of the humerus, in which complete paralysis of the median nerve persisted at the end of three weeks, when the patient was lost sight of.‖ It is not surprising that all these cases of nerve injury should have been met with in the upper limb, for the nerve trunks of the arm are of all others most exposed to pressure against subjacent bone. Langenbeck has given up the use of the tubing in the arm, and there can be no need for it, as the artery is so readily compressed against the humerus by the less harmful flat elastic bandage. The external popliteal nerve is the only one in the lower limb which is at all similarly exposed to serious pressure.

This danger, then, is a real one, but is very easily escaped by avoiding unnecessary compression around the arm, and in particular that of the elastic

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* *New York Med. Jour.*, Sept. 1877. † *Amer. Med. Jour. of Med. Science*, 1879.
‡ *Wiener Mediz. Wochenschrift*, June 21, 1878. § *New York Med. Record*, 1874, p. 257.
‖ Quoted in *Med. T. and G.*, Jan. 24, 1874.

tubing. Should the bandage be applied to the leg only, for an aneurism of one of the tibial arteries low down, the tubing should not be applied over or just above the head of the fibula, where it may injure the external popliteal nerve.

7. *Another objection raised to this treatment is that in cases of thin-walled aneurisms it may cause rupture of the sac.* Only one case where this has occurred has been recorded (No. 66), although in several instances special measures have been adopted to fill the sac as full of blood as possible. In any case where this result was to be specially apprehended it would be advisable to support the sac by carrying the bandage lightly over it, as has been done by several surgeons.

In one case (No. 35) the aneurism became larger, with increase of all the symptoms, immediately after this treatment.

8. *The last objection that has been raised to this method is the proportion of cases in which it has not proved successful.* The appended Table shows a large proportion of failures, many of which, however, must not be put down as failures of the method so much as failures to carry out the method. This objection applies equally to other forms of the treatment by compression, but with this difference, that they all take many days, or even weeks, for trial—this but a few hours; they appear to lessen the success of subsequent ligature of the artery—this does not.

The exact proportion of failures, and the causes of each, will be more suitably dealt with in the next chapter.

CHAPTER V.

STATISTICAL EXAMINATION OF THE TABLE OF CASES. SUBSEQUENT HISTORY OF THE CASES NOT CURED BY THIS METHOD.

Among the cases which I have been able to collect in the appended Table, there are several of which the records are very scanty; and at the same time it is practically certain that the Table does not contain all the cases of aneurism treated by rapid elastic complete compression. Any statistical deductions from this Table, then, are only approximately correct, and must be received and used with caution.

Of the seventy-two cases tabulated, the treatment resulted in cure of the aneurism in thirty-five. Of the remaining thirty-seven cases the result was doubtful in two (Nos. 27, 71), death occurred during the treatment in five (Nos. 30, 41, 53, 61, 68), and in thirty the aneurisms were not cured. Roughly stated, success has been obtained in fifty per cent. of the cases treated. Those cured consist of twenty-eight popliteal, five femoral, one iliac, and one anterior tibial aneurism. Failure occurred in twenty-four cases of popliteal aneurism, three of femoral, two of brachial, one of axillary, and one of internal cir-

cumflex aneurism. The points which can with most advantage be brought to the statistical test are the following:—

1. Age of patients.
2. Constitutional disease.
3. Character of aneurism.
4. Seat of aneurism.
5. Effect of preliminary treatment.
6. The frequency, duration, and exact mode of application of the elastic compression.
7. The duration and kind of subsequent treatment.
8. The subsequent history of the cases in which this treatment failed.
9. The influence of anæsthetics.

1. *Age of Patients.*—The youngest patient was aged twenty (No. 67), the oldest was aged sixty-nine (No. 7). The average age in forty-nine cases was thirty-eight years.

Between the ages of 20 and 30 there were 9 cases.
" " 30 " 40 " 23 "
" " 40 " 50 " 13 "
" " 50 " 60 " 3 "
" " 60 " 70 there was 1 case.

The average age of those cured was in twenty-five cases thirty-eight years and two months.

The average age of those not cured was in nineteen cases thirty-eight years and nearly nine months.

2. *Constitutional Disease.*—Syphilis is noted in ten cases (Nos. 10, 12, 14, 17, 19, 41, 42, 57, 60, 61), and in one case it was doubtful (No. 63). Of these ten cases seven were cured, two were not cured, and one patient died from rupture of another aneurism (No. 61). Of the two cases of failure one was from non-organisation of the clot (No. 41), the other from non-formation of a clot (No. 42). Atheroma is mentioned in seven cases (Nos. 21, 32, 33, 36, 40, 49, 60), of which only two (Nos. 21 and 60) were cured, and five were uncured. Of these five no clot was formed in two (Nos. 32, 36), and a clot formed and afterwards disappeared in one (No. 33); it is not stated whether a clot formed or not in the other two cases. A history of alcoholic excess is recorded in five cases (Nos. 1, 3, 5, 22, 33), of which only one case (No. 33) failed through disappearance of the clot. Phthisis is noted in Cases 30 and 33, and albuminuria in Case 36.

The evidence afforded by these figures is not very substantial, but such as it is, it shows that constitutional syphilis is no bar to the success of this treatment, while atheroma seems to render the prospect of success less; but it must be here observed that in Case 33 no compression was applied to the artery to

protect from disintegration the soft recently-formed clot. The number of cases in which the constitutional condition of the patients is noted is, however, so small that it is quite unsafe to draw any inferences from them.

3. *Character of Aneurism.*—In Dr. Reid's case only is it actually stated that the aneurism belonged to the sacculated variety, and three cases are stated to have been fusiform (Nos. 33, 36, 64), one of which was cured; in one of Mr. Heath's cases (No. 22) the aneurism was probably fusiform—it was cured. Six cases are stated to have been caused more or less directly by injury (Nos. 30, 52, 57, 59, 62, 67), three of which were cured (Nos. 57, 59, 67), one died under the treatment (No. 30), and the remaining two were not cured. Two of the aneurisms were false (Nos. 26 and 68), one was cured, the other died under the treatment. M. Debaisieux's case (No. 69) was a varicose aneurism, and resisted his efforts to cure it by this method.

In the descriptions of several of the tumours, it is either stated or implied that the sac was thin, or not lined with an appreciable amount of fibrin (Nos. 6, 9, 16, 17, 19, 42, 60), and all of these except Mr. Bellamy's case (No. 42) were cured. On the other hand, two of the aneurisms evidently had a thick deposit of fibrin or clot lining the sac (Nos. 14, 56)—both of these cases were cured. The size of the aneurisms varied very much, and the Table does not show that either the large or the small ones predominate among the successful or the unsuccessful cases. Taking the duration of symptoms—whether pain, pulsation, or a tumour—as the guide to the duration of the disease, it is found that the average duration of eighteen successful cases, where this detail is noted, was nearly eleven weeks, the extremes being two weeks and five-and-a-half months. Of thirteen unsuccessful cases the average duration at the time the treatment was commenced was 20·3 weeks, the extremes being nine days and two-and-a-half years.

The following Table shows the facts more accurately:—

Duration of Symptoms Previous to Treatment.	Of Successful Cases.	Of Unsuccessful Cases.
Under 10 weeks	10	7
Over 9 and under 20 weeks	5	1
„ 19 „ 30 „	2	1
„ 29 „ 40 „	1	1
„ 50 „ 100 „	0	1
„ 100 „ 150 „	0	1

From this it is seen that more than one-half the cases of each series were recent aneurisms, but that long duration of an aneurism to some extent lessens the prospect of cure. Other practical deductions from the above facts are that fusiform aneurisms are not favourable cases for this treatment, and that it is alike useful in aneurisms with thin walls, and in those with thick sacs lined by more or less fibrin or clot.

4. *Seat of Aneurism.*—The Table includes—

55	Cases	of	popliteal	aneurisms,	of which	28, or 53·8 per cent.*	were cured.
9	,,		femoral	,,	,,	5, or 62·5 ,,	,,
2	,,		anterior tibial	,,	,,	1, or 50 ,,	,,
2	,,		brachial	,,	,,	0, or 0 ,,	,,
1	,,		subclavian	,,	,,	? or ? ,,	,,
1	,,		axillary	,,	,,	0, or 0 ,,	,,
1	,,		external iliac	,,	,,	1, or 100 ,,	,,
1	,,		internal circumflex	,,		0, or 0 ,,	,,

5. *The Effect of Preliminary Treatment.*—It is very desirable to learn whether such treatment as was adopted in many of the cases before the use of the elastic bandage aided or hindered its success. But probably the Table of Cases is less to be depended on for information on this point than on others, as it is extremely probable—nay, certain—that in many of the records of cases, notably those made verbally at Societies, this item would not be included. It is not at all a warrantable inference that silence on this point is evidence that preliminary treatment was not adopted. The Table, however, shows that—

	Cases submitted to some form of preliminary treatment.
Of 28 cases of popliteal aneurism cured by this treatment	10, or 35·7 per cent.
Of 24 cases, not cured	6, or 25 ,,
Of 5 cases of femoral aneurism, cured . . .	2, or 40 ,,
Of 3, not cured	1, or 33 ,,

None of the cases of aneurism of other arteries are stated to have been previously treated.

This shows a distinct difference in favour of preliminary treatment, for the cases in which it was adopted figure more numerously among the cured than the uncured. Looking at the same facts from another point of view, we see that while the percentage success of all cases is 53, the percentage success of cases stated to have had some form of preliminary treatment is 63·6.

The preliminary treatment adopted has varied greatly. In one successful case (No. 4) it consisted of rest in bed for ten days; in one unsuccessful case (No. 35), of rest in bed for three days. Iodide of potassium was given in four cases (Nos. 7, 17, 20, 58): all of them successful. The diet was restricted in several cases. In Dr. Reid's case (No. 1) it was farinaceous. In Mr. Croft's first successful case (No. 6) the man was placed on milk diet for three days; his second successful case (No. 17) was placed on milk diet with meat. Mr. Goodsall placed his patient (No. 13) on "low diet" for six days. A dry, meat diet was ordered for five cases (Nos. 5, 18, 20, 57, 58), all of which were cured.

* In calculating the percentage the doubtful cases are excluded.

Other forms of compression had been tried in eight cases (Nos. 1, 21, 31, 48, 49, 55, 57, 63), four of which were cured, and four not. These numbers are very small; such as they are, they support the view that previous compression has no influence one way or the other, and that previous administration of iodide of potassium, with a dry, albuminous diet, may be of some use. If we seek evidence from other sources, we shall find that a certain amount has been accumulated to show that both a dry albuminous diet and iodide of potassium favour coagulation in aneurisms. The teaching of our Table being, therefore, in harmony with results obtained in other cases and by other observers, is worthy of more weight than the small number of cases from which it is drawn of itself would make it. In thinking of the coagulability of blood, two different things must be kept quite distinct—the readiness with which blood coagulates, and the amount of fibrin which it contains. The blood in acute sthenic inflammation, for example, coagulates more slowly, but contains more fibrin, than in health; in one sense it is more, in the other less, coagulable than healthy blood. The quantity of fibrin contained in blood is known to vary in physiological states, especially being increased during pregnancy; and bearing in mind the intimate and direct influence of the food upon the composition of the blood, probably none would doubt the feasibility of altering the proportion of fibrin by varying the diet, or even by administering drugs. But this is of comparatively slight importance in the cases under our consideration. We need a rapid and certain separation of the fibrin rather than a large amount of it. Hyperinosis alone is of no advantage in these cases, unless combined with great readiness of coagulation. It appears that very little is known with certainty about the actual process of coagulation, for we have recently been told that Schmidt's views about fibrinogen, fibrinoplastin, and fibrin-ferment escaping from the white corpuscles to excite the union of the two into fibrin, are inaccurate; that there is no such thing as fibrinogen, and that the "ferment" is contained in the red rather than in the white corpuscles. If this question could be settled, then it would be possible by experiment to determine whether diets or drugs affected in any way the proneness or the power of the corpuscles to give out the all-important fibrin-ferment. But while the physiology of coagulation is deficient, the therapeutist must act empirically.

6. *The Frequency, Duration, and Exact Mode of Application of the Elastic Compression.*—Of the twenty-eight successful cases of popliteal aneurism, cure followed after one application of the bandage in eighteen cases, after two applications in five cases, after more than two applications in four cases, and in one case (No. 9) exact details of the treatment are wanting; in other words, the first application of the bandage was successful in two-thirds of the cases. In the unsuccessful cases of popliteal aneurism, the elastic bandage was applied once in five cases, twice in four cases, and more often in nine cases. Of the cured femoral aneurisms, the first application of the bandage was successful

in three cases, the second and the third each in one case. In the uncured cases of femoral aneurism the bandage was tried once in one case, twice in one case, and forty-two times in the third case (No. 64). In the cases of aneurism of other arteries, the first application of the bandage was successful in two cases; and in the four cases of failure the bandage was applied once in two cases, twice in one case, and thrice in the other case. The general result can be stated thus:—In 67·6 per cent. of the cases cured, the first application of the bandage was successful; in 17·6 per cent. cure followed the second application; and in 14·7 per cent. of the cases cured the bandage was applied more than twice. In the cases in which the treatment failed, the bandage was applied once only in 32 per cent., twice only in 24 per cent., and more than twice in 44 per cent. We thus get evidence from both classes of cases that repetition of the application of the bandage has not been in itself an element of success, for in more than half the cases of cure the bandage was only applied once, and in more than half (in fact, the same proportion) of the cases of failure the bandage was applied twice or oftener. But failure on the first attempt does not of itself warrant abandonment of further trials of this treatment.

The duration of the successful application of the bandage is stated in twenty-nine cases; it varied from half an hour to three and a half hours, and the average was a few minutes under one and a half hours. The details are seen in the following Table:—

Elastic bandage applied with success for under 1 hour		in 5 cases.
,, ,,	for 1 hour and not ex. 2 hours	18 ,,
,, ,,	more than 2 hours ,, 3 ,,	2 ,,
,, ,,	,, 3 ,,	4 ,,

The bandage was applied sixty-nine times without success, for periods exactly stated in the reports of the cases, which vary from twenty-five minutes to five hours, the average duration being 133 minutes:—

Elastic bandage unsuccessfully applied for under 1 hour		30 times.
,, ,,	for 1 ,, and not ex. 2 hrs.	34 ,,
,, ,,	,, 2 hours ,, 3	3 ,,
,, ,,	for over 3 ,,	twice.

From this it appears that one and a half hours may be regarded as the average time during which the bandage should be applied, and that a longer application than this is attended with only very slight prospect of good.

Of the modes of applying the bandage, it may be said that in twenty-five cases it was applied above and below, but not over, the aneurism; in fifteen cases the bandage was applied over the aneurism as well; and of the former, seventeen, or 68 per cent., were successful, and of the latter, ten, or 66·6 per cent. were successful, showing that this detail has no practical importance so far as the cure of the aneurism is concerned. In one case (No. 7), the cure of a popliteal aneurism was obtained by applying the elastic tube only tightly round the thigh. The same plan was tried in a case of femoral aneurism (No. 56); a clot formed in the aneurism, but afterwards broke down; yet, as the formation

of the clot is the only result directly following the use of the bandage, this must be regarded as a second successful result of this simple means. Dr. Madelung tried this plan, and found it ineffectual in his case (No. 55). Manipulation of the sac during stasis of the blood within it, was tried by Mr. Page (No. 34), but without material benefit. The elastic constriction above the aneurism was replaced by the pad of a tourniquet in three cases (Nos. 60, 61, 65), in two of which the blood clotted. In some cases the tubing has been used around the highest turn of the elastic bandage, in others not; there is no mystical virtue in the tubing. It should only be used when the bandage alone fails to stop all flow of blood into the aneurism.

Some surgeons have used the elastic bandage in a way very different from that recommended by Dr. Reid. Their cases are but few, but yet sufficient to enable us to come to an opinion on the merits of the modifications.

In one case (No. 28), Mr. Thornton applied the elastic bandage not tightly enough to stop all pulsation in the tumour, the blood did not coagulate, and the cure was subsequently obtained by the use of Signoroni's and Carte's compressors. (In the various statistics given above, this case has not been included.) Mr. Bryant states that in one of his cases (No. 39), he applied the bandage firmly for thirty minutes, and more loosely for eighty minutes; presumably during this eighty minutes the circulation in the limb was not completely stopped. Dr. Weir, in one case (No. 30), applied the bandage in the usual way with the tube, but removed the tube four hours before he removed the bandage—presumably the bandage alone did not entirely stop the circulation, or the tube would not have been used. In Mr. Wright's case (No. 57) the same plan was followed, the bandage being left on the limb for an hour after the tube was removed. We have seen already that where the bandage is applied so as to stop all blood-flow in the part, it has a very special, important, and often useful effect. But when, as in these cases, some blood-flow is permitted, the altered conditions vary the effect. But further, Esmarch's bandage is used to cause blood stasis because it is the only known practicable method by which it can be done. But there are other ways of merely lessening the flow of blood through an aneurism, and the above cases suggest the question: Is the elastic bandage the best, or a good way, of doing this? It is more painful than other forms of compression, and it hinders the return of the small quantity of blood that does get into the limb. But if compression of the main artery fail, owing to a very free anastomotic circulation, the bandage affords a means of correcting this accident. In the general way, the elastic bandage should only be used to secure blood stasis in the aneurism and adjacent vessels; and for milder degress of compression, unless in the above exceptional cases, direct pressure on the main artery is preferable.

Another modification has been to remove the part of the bandage above the

aneurism before that below it. This was done by Mr. Goodsall (No. 13). The purpose of this, presumably, was to lessen the flow of blood past the newly-formed clot by keeping up the obliterating pressure on the vessels below: the result was successful. But I cannot but regard this procedure as a needlessly painful and otherwise bad way of attaining such an object. For not only is the pain of the bandage often very severe, but its effect is to keep a considerable part of a limb bloodless, simply to lessen the direct stream of blood through the main artery—a result easily obtained by proximal pressure on that trunk itself, while the limb below is nourished through the anastomotic vessels.

In one case (No. 66) the bandage was applied up to the aneurism, and no compressor was applied to the limb or to the artery above.

In one of Mr. Barwell's cases (No. 36) he protected the aneurism from the pressure of the elastic bandage by a tin plate placed over the tumour. This precaution appears to be unnecessary; indeed, slight compression or support of the aneurism by the elastic band may be desirable.

The most important modification of Dr. Reid's method is that of applying the bandage for a short time at frequent intervals. I have found altogether nine instances of this practice, seven of which are included in the Table of Cases. Four of these are reported by Mr. Thomas Smith (Nos. 8, 45, 46, 47). In the first of these the elastic bandage was applied "as long as the patient could bear it," and then alternated with a tourniquet, and after this alternation had been kept up for nine hours the aneurism was found to be solid. In the other three cases the elastic bandage and cord were applied for an hour or an hour and a half at a time, a tourniquet being placed on the artery in the intervals: none of them succeeded. Judging from these four cases, the result of this plan is not good. Nor should this be a matter of surprise. The plan consists in the alternate employment of two methods of compression differing in their effects on the local circulation, neither of which assists the other. Stasis of the blood in an aneurism for an hour without its coagulation, does not favour the separation of fibrin from a stream of blood afterwards trickling slowly into the aneurism. Such a tardy flow of blood through an aneurism for an hour does not necessarily favour the coagulation of blood afterwards left stagnant in the aneurism for an hour, although if a separation of fibrin did occur, it might possibly start coagulation in the stagnant blood. The intermittent employment of Esmarch's bandage is likely to be as successful without the intervening compression of the main artery. The intermittent compression of the main artery will be as successful without the intervening applications of the elastic bandage. Professor Esmarch (No. 64) applied the elastic compression for half an hour at a time, three times a day, for forty-two applications without any good effect. Mr. Bellamy (No. 42) applied it for half an hour every four hours for four days, and at the end of that time the aneurism was larger than before. Dr. Madelung

(No. 55) applied it for thirty or forty minutes daily for fourteen days, and at the end of that time the sac was much smaller, but the pulsation was still forcible.

We have seen already that a previous stasis does not render the blood more ready to coagulate when stasis is repeated. And so in these cases the mere repetition of the act does not increase its therapeutic value. The coagulation of the blood is not a gradual but a rapid, sudden event. It results from the stasis of the blood in the aneurism; if it does not occur, either the blood is not coagulable under existing stimuli, or sufficient time is not allowed. The treatment, then, consists either in improving the plasticity of the blood, or in prolonging the time of stasis. But if one and a half hour's stasis fails to lead to coagulation, there is no well-grounded hope that two or three hours' will. When it is the design to obtain a gradual deposit of fibrin, intermittent compression may be advisable; but it should be direct and partial compression, and not the indirect and general compression of all the tissues. But the two most remarkable cases of this kind are the following:—

The first is recorded by Dr. Fritz Raab in the *Wiener Mediz. Wochenschrift*, 1878. A man, thirty-six years of age, noticed a small popliteal aneurism eight days after an effort in jumping; this increased in size, and became diffuse; he improved under treatment for some months, and then again became worse, and was then admitted to hospital under Billroth's care. The tumour was then double the size of the fist, with all the appearances of being diffuse; there was disease of the aortic valve, causing a double murmur. His limb was raised, and then the elastic bandage was applied firmly up the leg, loosely over the tumour, and again firmly up the thigh. The bandage was only borne a few minutes, and then removed. Gradually the man was able to bear it longer, *e.g.*, twenty minutes; directly on its removal Signoroni's tourniquet was applied to the artery at the groin. He left hospital after nearly a month's stay, and then treated himself by applying the bandage every other day. For a week later the tumour got smaller, but the pulsations were as strong as ever. The tumour again increased in size, and was daily treated by the bandage for twenty minutes, followed by Gersuny's tourniquet for several hours; nearly a fortnight later the tumour was solid and pulseless.

The other case is recorded by Gersuny in Langenbeck's *Archiv f. klin. Chirurg.*, 1877. In the right ham was an aneurism reaching from the middle of the thigh to the middle third of the leg. The skin over it was tense, œdematous, bluish, marked by large veins; the heart was hypertrophied, the arteries movable. The femoral artery was ligatured, but without avail; and several subsequent endeavours to cure the aneurism by mechanical compression failed. On January 25, 1877, the patient came under the care of Dr. Gersuny, who every other day bandaged the limb firmly with the elastic bandage for half an hour; in the intervals the limb was well bandaged, and Signoroni's tourniquet was applied to the femoral artery for from six to eight hours

every day. After February 4 the elastic bandage was applied every day. On February 11, the pulsation had nearly entirely ceased, and the patient was soon quite cured. When the elastic bandage was removed, the skin beneath it presented great venous hyperæmia, and even suggillations. In these two cases there was a slow gradual occlusion of the aneurismal sac, and it does not appear from the histories that any sudden coagulation occurred. In each case there was prolonged compression of the main channel, and they seem to be instances of cure of aneurism by Signoroni's tourniquet, the treatment being several times interrupted by the use of the elastic bandage without material effect. Although the aneurisms were cured, it is impossible to attribute that result to the use of the elastic bandage. For this reason they have not been included in the Table of Cases.

7. *The Duration and kind of subsequent Treatment.*—In thirty-two out of the thirty-five cases of aneurism which were cured by this treatment, some form of compression was applied to the main artery of the limb for a time varying from one to several hours. The minimum time was one hour (Case 13); the maximum cannot be stated, nor would it be a valuable fact, for it is impossible to assert that where the compression has been kept up for several hours it was needful to do so. The compression of the artery has been accomplished by the hand, or a bag of shot, or Signoroni's or Carte's compressor. It may be well to repeat that this compression is only of use so far as the cure of the aneurism is concerned, when the stagnant blood has coagulated. Its chief purpose is to protect the soft recent clot, to allow of its necessary increase in bulk, of its firm adhesion to the artery, and of the opening out of the anastomosing vessels. But even when the stasis of the blood has not been followed by its clotting, and on removal of the elastic bandage the aneurism is found to be pulsating as before and filled with fluid blood, this subsequent compression should not be omitted; for by checking the flow of blood into the limb it prevents the overfilling of the paralysed blood-vessels with the attendant risk of a fall of general blood pressure.

8. *The subsequent History of the Cases in which this Treatment failed.*—If this method of treatment were a "kill or cure" method, and those cases which were unsuccessfully submitted to it were injured by it, and their chance of cure by other means lessened, it would form a good ground for rejecting it. But the table of cases does not warrant such a view; for of the seventy-two cases, thirty-five were cured by the treatment, and the remaining thirty-seven are thus accounted for:—

Result of the treatment doubtful . . .	2	(Nos. 27, 71).
Cured by ligature of the artery . . .	20	
Cured by compression	3	(Nos. 52, 55, 64).
Cured spontaneously	1	(No. 69.)
Cured by introduction of catgut into sac . .	1	(No. 72.)

Subsequent history not stated	3	(Nos. 40, 54, 70.)
Artery ligatured unsuccessfully . . .	3	(Nos. 37, 41, 66.)
Died while under this treatment . . .	3	(Nos. 30, 61, 68.)
Limb amputated—death	1	(No. 53.)
Total . . .	37	

Of the twenty-five cases cured it is needless to say more; but the last seven cases of the above table deserve individual attention.

Three cases were ligatured unsuccessfully. The first of these was Mr. Bryant's case of gangrene (No. 37), to which reference has already been made. The second was Mr. T. Smith's (No. 41), where the patient died from blood-poisoning. The third was a case of the late Mr. S. M. Bradley's (No. 66), thus described in the *Brit. Med. Journ.*, 1877, vol. ii. p. 810. "The patient, a man aged thirty-seven, previously healthy, was admitted into the Manchester Infirmary with an aneurism, which was clearly circumscribed at the inner side of Scarpa's triangle. After a few days rest Esmarch's bandage was applied and retained for an hour; the tumour was so high in the thigh that the upper encircling bands pressed upon the tumour, and to this Mr. Bradley attributed the fact that from this date the aneurism became diffuse. On removing the bandage pulsation ceased, and the tumour felt harder; the following day, however, pulsation was detected, but only along the outer margin of this mass: along this track, a *bruit* was audible, and the tumour had increased in size. The next day the increase was so marked and the skin so tense, that Mr. Bradley tied the common femoral immediately below Poupart's ligament. On tightening the ligature, which was of catgut, pulsation ceased. The following day, however, there was a return of pulsation, and presuming that the ligature had slipped, Mr Bradley proceeded to secure the vessel with a silken ligature. On exposing the previous ligature, the artery could be seen beating on both sides of it, clearly showing how imperfect was the hold of the catgut. A silk ligature was on this occasion passed round the vessel above and below the points of the previous deligation; and, on tying the silk tightly, once more pulsation ceased in the aneurism. In spite of this, however, the tumour still increased in size; and, two days afterwards, pulsation was once more noticed, following the same isolated track along the outer side. The aneurism being clearly diffused, Mr. Bradley amputated the limb just above the origin of the profunda. It was now found that the aneurism sprang from the internal circumflex branch of the profunda, and was diffuse; the superficial femoral, quite healthy, coursed along the external wall of the sac. This explained the returned pulsation, which, in the first instance, was due to yielding of the catgut; in the second, to a free collateral circulation flowing through the circumflex iliac artery into the ascending branch of the external circumflex, thence into the profunda, and so on into the superficial femoral. After a favourable progress for several days,

secondary hæmorrhage ensued, and the man eventually died with symptoms of pyæmia. Mr. Bradley remarked that this case went to prove that applying Esmarch's bandage to a limb is dangerous when the encircling folds impinge upon the aneurism." In the two former cases the use of the bandage had no influence upon the failure of the subsequent ligature of the artery. In the last case it is quite open to question whether the highest turns of the elastic bandage did not so injure the aneurism as to favour or even cause its becoming diffuse. But, as a set-off to this, it is to be noticed that it is not usual to apply the bandage in this way; and that a clot formed in the aneurism, but that no subsequent compression was used to protect that clot from the disintegrating force of the flowing blood. The rupture of the sac was, undoubtedly, a very serious result of the application of the bandage; but this case does not show that such a result need be feared if the precautions usually observed are taken.

Three cases died while under this treatment. The first case (No. 30) is thus described by Dr. Weir in the *Archives of Medicine*, April, 1880.

"Matthew Miner, a coloured man of thirty-eight years of age, of phthisical habit though in good condition, entered the New York Hospital, January 15, 1880, with a large popliteal aneurism of the right leg, which had existed about four months. He attributed the enlargement to an injury incurred by his foot slipping while he was lifting a heavy box. One week after this strain he felt a sharp pain in the right popliteal space, and after three weeks of neuralgic twinges in the limb, he noticed a pulsating swelling in the ham. The tumour was found on his admission to the hospital to be somewhat larger than the closed fist, filling up the popliteal space, pulsating freely and expansively, and with a loud sharp bruit most noticeable at its upper part. The arteries in the groin and at the wrist seemed normal. At 3.45 P.M. the same day Esmarch's elastic bandage was applied, not very snugly, up to the tumour. The patient was then stood erect, and a second elastic bandage carried around the limb above the aneurism to the middle of the thigh, where the rubber tubing was tightly secured. The tubing was left on until 6.20 P.M., *i.e.*, two hours and thirty-five minutes, when it was removed, but not the bandage. A Signoroni's tourniquet was now applied, and retained with the bandage until 8.10 P.M., one hour and fifty minutes longer. This plan was adopted, as it had been noticed in this case as in my first case that the elastic bandage by itself did not control absolutely the current through the aneurism, and also that in my second case Nicaise's tourniquet answered so happily. Moreover, we thought by thus keeping on the bandage, that such firm compression by the tourniquet would not be demanded. The total compression was four hours and twenty-five minutes in duration, with the result of producing a consolidation of the aneurism. The patient was a man of strong will, and declined to take ether, and only received during the treatment a single hypodermic injection of ℥x of Magendie's solution of morphia. The next day it was found that the pulsa-

tion had returned, but the leg was of natural temperature, though somewhat more swollen from the knee to the ankle.

"On the 18th inst. the elastic bandage and tubing were applied as before, and retained from 5.20 P.M. to 8.10 P.M. (*i.e.*, for two hours and fifty minutes) when the rubber tubing was removed, and the bandage alone continued—through an error in my directions, an hour longer than was intended—on the limb, until 12.10 A.M., when the bandage was taken off and a Signoroni's tourniquet applied for half an hour longer at the groin. No bruit or pulsation was then to be detected in the aneurism, and the whole leg was cold and insensitive. The time occupied by the compression was in all seven hours and twenty minutes, during six hours and fifty minutes of which time the elastic bandage had been on. The patient had as before borne the pressure so well that only one hypodermic injection of morphine, gr. $\frac{1}{4}$, had been given. No ether was used, though ordered if the pain should be severe. His general condition, when left for the night, as far as noticed, was good. As a precautionary measure a seven pound bag of shot was laid over the artery at Poupart's ligament. The next morning, January 19, when seen at nine o'clock by the house-surgeon, the patient stated that he felt all right, only a little weak; but on trying the pulse at the wrist it was found to be nearly absent, and in the femoral artery it was very weak and irregular. Temp. 101–2°. P. 78. Aside from the pulse, there were at that time no marked evidences of shock. The right leg from just below the knee to the toes was cold, and in the plantar surface of the foot were irregular mottled patches, but not more so than had been observed in my first case (a successful one, No. 56). No pulsation was to be detected in the aneurism or tibials, though in the superficial femoral above the aneurism it could be recognised. The patient was also able to move the limb. The whole leg and thigh were immediately enveloped in cotton, and hot air directed under the bed clothes, and whisky administered, $\bar{3}$ss, every half-hour by the mouth. At two o'clock in the afternoon the toes and sole of the foot and the upper and posterior part of the leg had become warm, and the area of coldness and duskiness now extended only from the root of the toes dorsally to half-way up the leg anteriorly, and embraced nearly the full width of the limb. The patient's general condition had not changed for the better. Pulse at the wrist entirely absent; face bathed in perspiration; T. 99°; P. 58; no anxiety of countenance; not any mental disturbance. The patient said again he felt all right, with the exception of a slight nausea and sinking sensations.

"Hypodermic injections of ether and whisky were joined to the external exhibition of stimulants, but the patient never rallied, and at 4 A.M., January 20, a little more than twenty-seven hours after the cessation of the compression, he died.

"The autopsy twelve hours later revealed no evidence of change in the tissues

of thigh, leg or foot of the affected side, except that the epidermis of the great and two adjacent toes near the nails could be easily detached, and looked as if this had resulted from a burn from the hot-air apparatus. Slight serous infiltration and minute capillary hæmorrhages were visible, more particularly in the deeper part of the limb. The right leg measured two and a half inches larger at the calf than the left, and on the skin above and below the aneurism could be seen a zone of deeper colour than elsewhere, and apparently marking the site of the rubber bandages.

"The artery and veins from the aorta to the foot were removed and carefully inspected. The veins were normal, and filled with recently clotted blood. The femoral artery above the aneurism was empty of clot, and above the profunda the coats of the artery were normal; below this point to the aneurism, however, the artery was rough and thickened. Nowhere was there any obvious deposit of atheroma except one small patch in the common iliac. The artery below the tumour was filled to some distance below the bifurcation of the popliteal with a small amount of soft recent clot. The aneurism itself which sprang from the anterior wall of the artery through an oval opening one and a quarter inches long, was twelve inches in circumference, and was filled with a well-formed recent clot. The anterior crural nerve at the point of pressure of the rubber tubing and tourniquet appeared normal.

"Further examination showed advanced fibrous phthisis in both lungs, an atheromatous aorta, and microscopically a distinctly fatty degeneration of the muscular fibres of the heart, more particularly observed in the right than in the left ventricle. The other organs, brain, liver and spleen were normal. The kidneys were intensely congested, but otherwise normal."

I have quoted this description at length, because this case is worthy of most careful study by all surgeons contemplating employing this treatment. The points to which attention should be specially directed are—(1.) That the bandage was successful in causing clotting in the aneurism and artery; therefore, if death were due to the treatment, its cause was a danger to which *successful* cases are exposed. (2.) The actual cause of death. The prominent symptom was a weak, irregular, small, and infrequent pulse. This is the characteristic pulse of fatty degeneration of the heart, and at the autopsy the heart was found distinctly fatty. No other cause of death was found, and we may safely say that the man's fatty heart was the cause of his death. It is quite clear that the use of Esmarch's bandage had no influence in causing this fatty heart; but did it so increase the difficulty of the heart as to lead to its breakdown? Or was that breakdown entirely unconnected with the treatment to which the man was exposed? Probably few would be found to assert that the treatment and the fatal result are entirely unconnected. This case, then, is not so much an argument against this treatment, as evidence of its unsuitability in cases of fatty heart, and proof of the necessity of a careful and complete examination of the patient previous to treatment.

The next case of death was one under Mr. F. A. Heath's care (No. 61), no full account of which has been as yet published; but I have to acknowledge Mr. Heath's courtesy in kindly allowing me to look over his notes of the case. The patient was a man thirty-seven years of age, a weaver by trade, who was admitted to hospital with an aneurism of the common femoral artery, which had been noticed about fifteen months. Esmarch's bandage was applied twice. On the first occasion the bandage was applied up to and over the aneurism for an hour, Lister's aorta tourniquet being applied to the aorta for two hours, and to the common iliac artery for ten and a half hours; and this was followed by digital compression of the iliac artery for thirteen hours. On the second occasion the tourniquet was retained on the aorta for ten and a quarter consecutive hours. The sac of the aneurism was noticed to be consolidated, but extreme collapse occurred, which ended fatally. At the autopsy the aneurism was found to be filled with coagulated blood; the anterior part of the clot was firm and resistant, the posterior part was softer and looser, and readily broke down under the finger. A large quantity of blood was found extravasated in the belly, which was found to come from a ruptured aneurism of the aorta, situated near its bifurcation, and close above the part compressed by the tourniquet.

It is quite impossible to apportion exactly the share in the causation of this patient's death that belongs to the aneurism and to the aortic compressor; but in any case it only shows that such compression should not be applied close below an aneurism. The case cautions surgeons to bear in mind the possibility of the existence of an internal aneurism in all cases of external aneurism; but it cannot fairly be quoted as an argument to show the special danger of this particular treatment of external aneurisms.

The third fatal case is Mr. Rivington's (No. 68), and from the account of it published in the *Lancet*, 1880, vol. ii. p. 608, I extract the following:— Arthur W., a labourer, aged fifty-eight, was admitted into the London Hospital on Feb. 8, 1877. About six weeks before, while walking upstairs, he felt a pain in his right leg just below the knee, and on looking at it, he found a swelling not larger round than a halfpenny, and the same night he felt it pulsating under his fingers. The swelling was poulticed, and two days before admission it was opened, and blood spurted out from it. On admission to hospital there was found a large oval swelling, commencing a few inches below the knee, and having its long axis parallel with the axis of the limb, the skin over it was red and inflamed, the swelling gave a sense of fluctuation, pulsated strongly, and over it a loud rasping bruit was heard. The calf bulged and pulsated. Large glands were found in the groin. The superficial veins of the leg were enlarged. Compression of the femoral artery by a screw tourniquet was applied. On Feb. 11, Esmarch's bandage was applied for an hour, from toes to middle of thigh, but loosely over the tumour;

coagulation did not occur. The tourniquet was again adjusted, and next day free hæmorrhage occurred from the incision into the swelling. The patient persistently refused any operation. The man was put under chloroform, and Esmarch's bandage was applied as before, for one hour and twenty minutes, and then digital compression was maintained "for some time longer." Pulsation had not wholly ceased in the aneurism after the removal of the elastic tube, but when coagulation in the sac was completed, the heel became hot, but the anterior part of the foot and the toes cold, and the surface mottled. The gangrene advanced as far as the lower third of the leg. The man died, having suffered towards the close from anorexia, restlessness, delirium, pyrexia, and basic pneumonia. The *post-mortem* examination showed a nearly complete solution of continuity of the anterior tibial artery, and its ruptured part was occupied by a sac composed of the surrounding tissues and blood-clot. The sac was filled with broken down clot. The aneurism was situated a few inches from the origin of the vessel, and this portion contained a clot of partially discoloured fibrin, and the clot extended into the popliteal artery. It was by no means clear that the clot in the artery had not formed at the time that the blood coagulated in the sac.

The cause of death in this case was the gangrene. But there is no evidence that the treatment pursued had any share in its production. The aneurism was diffused and of large size, and, in all probability, the deep veins of the limb were seriously compressed; and so, when the blood in the sac and artery coagulated, the venous return became altogether impossible, and gangrene resulted. This case can never be fairly adduced as evidence of the danger attending the use of Esmarch's bandage.

In one case (No. 53) the aneurism consolidated, but gangrene of the limb ensued; for this amputation was performed, and the patient died. This case —Mr. Pemberton's—has already been noticed, and it has been shown that the cause of the gangrene was the obliteration of the popliteal vein by the aneurism, and that the same result would have attended the cure of the aneurism and obliteration of the artery, however obtained.

The evidence before us, therefore, warrants the assertion that the use of Esmarch's bandage does not prejudice the chance of cure by other means. Of sixty-seven cases of aneurism treated by this means, and of which the subsequent history was known, sixty were by it, or by other means, cured.

9. *The Influence of Anæsthetics.*—Mr. Croft has suggested (*vide Lancet*, 1880, i. 289) that the prolonged use of anæsthetics may retard coagulation. On analysis of the cases in the Table, with the view of getting information on this point, I find that in eight cases morphia (in one case opium) was given, and of them seven were cured. Chloroform was administered eight times, and only three of the cases were cured. Ether was used five times, and all the cases were cured. Bichloride of ethedene was used in one successful case; morphia

and chloroform were both used in one successful case. In twelve cases it is expressly stated that no anæsthetic was used, and nine of them were successful. This particular is omitted from a large number of reports of cases, and the above numbers are too few to make deductions from them of great value.

CHAPTER VI.

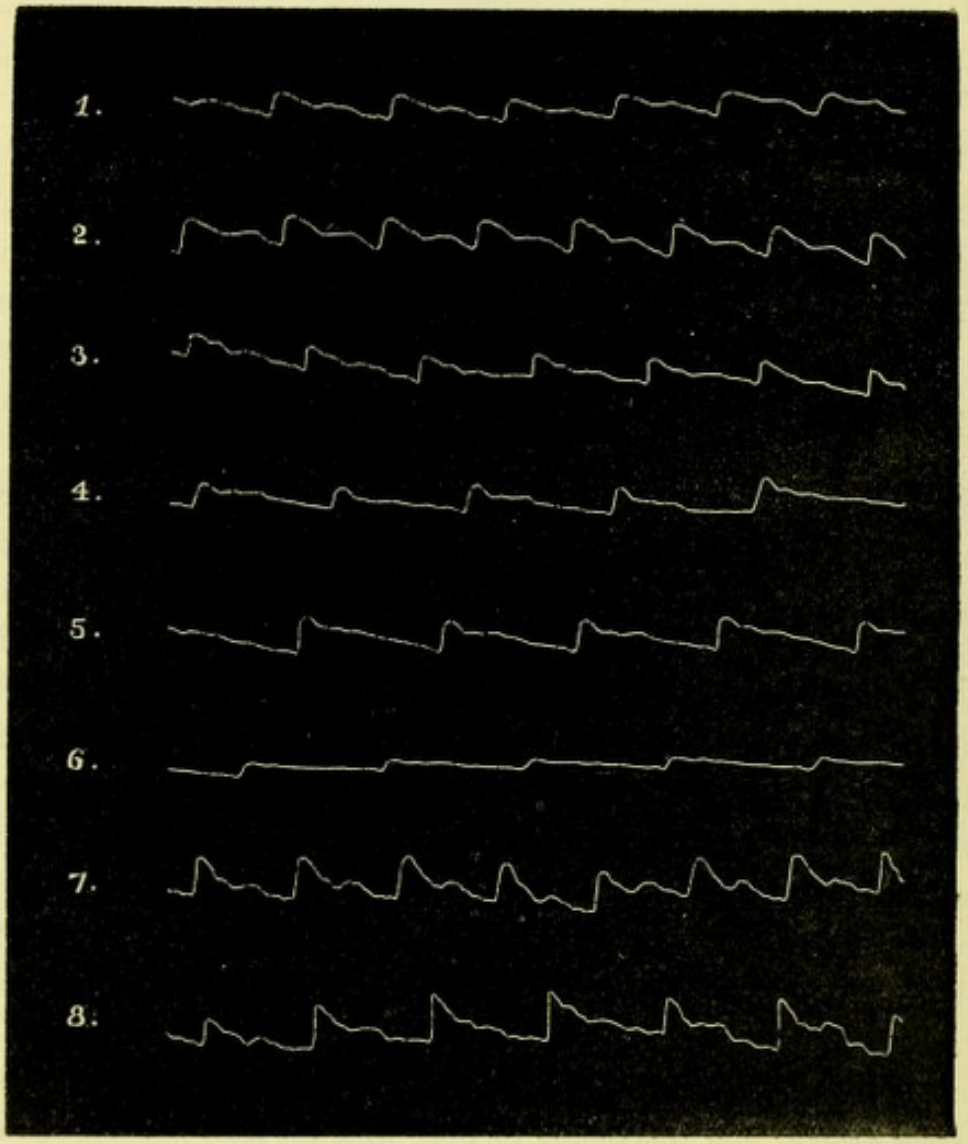
CONCLUSIONS.

It is not necessary to recapitulate the facts, or deductions from them, recited in the previous pages; but there are some few conclusions that it may be well to state here. The first of these is that Dr. Reid's method of treatment has hitherto been so successful, and in so short a time, is so easily applied, and its success or failure so readily recognized, that it is well worthy of adoption in suitable cases. Its alleged dangers and disadvantages we have seen to be, in most instances, exaggerations; and there are none which may not be obviated by a judicious selection of cases and a careful attention to the details of the treatment. I would wish again to emphasize the fact, that cure of an aneurism by this method is not obtained in the same gradual manner as by most other methods, but is rapid: it is never partial—a mere improvement—but is complete; and it depends on the organisation of a thrombus formed in the diseased artery.

In the selection of cases suitable for this treatment, the most important point is an otherwise healthy blood-vascular system. Wherever possible, preliminary treatment should be employed, with the view of increasing the coagulability of the blood; the most successful treatment of this kind is a dry albuminous diet, and the administration of iodide of potassium in full doses. The bandage must be applied so as to secure complete stasis in the aneurism and adjacent artery: but this should be done with the least possible disturbance of the general circulation; and, therefore, the blood should not be expressed from the whole of the limb below the aneurism, but only from the part immediately below the tumour. Stasis should be kept up for one and a half. hours. If the aneurism is at the end of that time solid, the bandage should be removed, and the main artery of the limb compressed by the finger or tourniquet for six to twelve hours. If the blood has not clotted in the aneurism, such compression should equally be employed. Wherever the aneurism is of large size, and, especially, if rapidly growing, the elastic bandage should be carried lightly over the tumour. When this treatment fails, the artery above may be ligatured with as good a prospect of success as if no previous treatment had been tried.

Sphygmograms.

(*Vide p.* 19.)



1. Tracing of radial pulse of H. before Esmarch's bandage was applied.
2. " " Esmarch's bandage applied from toes nearly to groin for ten minutes.
3. " " after removal of the bandage. (Pressure 40 grms.)
4. " " S. before Esmarch's bandage was applied.
5. " " when Esmarch's bandage had been applied from toes nearly to groin for ten minutes.
6. " " just after removal of bandage. (Pressure 40 grms.)
7. " " W. before Esmarch's bandage was applied.
8. " " when Esmarch's bandage was applied from toes to groin. (Pressure 60 grms.)

Cases of Aneurism treated by Esmarch's Elastic Bandage.

ANEURISMS OF POPLITEAL ARTERY.

No.	*Name of Surgeon and Reference.*	*Clinical History.*	*Characters of Aneurism.*	*Treatment.*	*Result.*
1	Dr. W. Reid. *Lancet*, 1875, ii. 448, & 1876, ii. 184.	Marine, æt. 37. Strain while lifting sails 3 months before, hypertrophy of heart, cirrhosis of liver.	Sacculated: of "considerable size, with strong pulsation."	Rest and farinaceous diet; then genuflexion, followed by Carte's compressors—no improvement. Esmarch's bandage from instep to middle of thigh—lightly over tumour; elastic tubing applied and bandage removed; aneurism unaltered in size: tubing removed in 50 minutes—Carte's compressors applied intermittently at the groin for 30 hours.	Cured. Patient died subsequently from bronchitis, &c.
2	Mr. Wagstaffe. *Lancet*, 1876, ii. 401.	Barman, æt. 32. Strain 4–5 months previously. Throbbing noticed 2 months.	2 in. long, filling upper half of popliteal space.	Esmarch's bandage up to, and lightly over, tumour, and firmly up the thigh; tubing not used; removed in 50 minutes: 2 tourniquets applied to control artery for 6½ hours: more loosely for 11¼ hours, and very loosely for 11 hours more.	Cured. Patient died subsequently from rupture of small aneurism of aorta, atheroma of aorta; other arteries healthy.
3	Mr. F. A. Heath. *Lancet*, 1876, ii. 638.	Labourer, æt. 29. No history of syphilis; alcoholism. Symptoms noticed 3 weeks.	Aneurism size of small orange	Esmarch's bandage applied firmly as high as ham, patient then stood up, bandage lightly applied over tumour, and tightly up the thigh; tubing not used; bandage left on 1 hour. Signoroni's tourniquet applied for 5 hours, and loosely for 2 days more.	Cured. No pulsation when bandage removed. Anastomotic arteries felt pulsating over knee.
4	Mr. T. Smith. *Lancet*, 1877, i. 750.	Bonnet blocker, æt. 45. No history of syphilis. Symptoms noticed 3 weeks.	Aneurism size of a hen's egg, pulsation very forcible.	Rest in bed 10 days. Esmarch's bandage applied up to the aneurism, not over it, and then up the thigh; left on for 1 hour. Signoroni's tourniquet applied for 2 hours.	Cured.
5	Mr. Tyrrell. *Lancet*, 1877, i. 940.	Grocer, æt. 36. No history of syphilis; history of alcoholism. Pain in ham 6 weeks; pulsation noticed 12 days.	Aneurism measured 5 by 5½ in.	Restricted dry meat diet. Esmarch's bandage up to, lightly over, and firmly above, tumour; tubing applied; removed in 50 minutes. Digital compression to artery 2 hours; followed by compressor at groin "moderately tight."	Cured. Aneurism was quite hard, with a very slight pulsation when bandage was removed. Subsequently the articular arteries around the knee were seen and felt to pulsate.
6	Mr. Croft. *Lancet*, 1878, i. 85.	Woman, æt. 43. No history of syphilis. Pain felt 8½ months.	Aneurism was as large as an orange, pulsated freely, no appearance of clot.	Milk diet and rest 3 days. Esmarch's bandage up to and above aneurism, retained 1 hour; digital compression, 6 hours.	Cured. On removal of bandage pulsation at once recurred, though not so strongly as before.
7	Dr. G. B. Ferguson. *Lancet*, 1878, ii. 439.	Cabinetmaker, æt. 69. Temperate habits, arteries not apparently atheromatous. Symptoms noticed 3 months.	Aneurism size of a large hen's egg, expanding forcibly.	Rest in bed and iodide of potassium 1 week. Esmarch's elastic tube applied tightly round the thigh for 1 hour; then digital compression of artery 2 hours 20 minutes; tube for ½ hour; digital compression 1 hour; tube ½ hour; digital compression 1 hour 20 minutes; tube 1 hour; digital compression 1 hour.	Cured. Anastomotic arteries felt pulsating over the inner condyle and patella.
8	Mr. T. Smith. *Lancet*, 1878, ii. 880.	A medical man.	Not stated.	Elastic bandage applied below and above aneurism "as long as patient could bear it," then a tourniquet was firmly applied; this alternation was continued throughout the day: after nine hours there was severe pain at the seat of the aneurism.	Cured. The art. anastomotica was seen to pulsate after the consolidation of the aneurism.

No.	Name of Surgeon and Reference.	Clinical History.	Characters of Aneurism.	Treatment.	Result.
9	Dr. McDougall. *Lancet*, 1878, ii. 880.	Not stated.	Aneurism was large with thin walls.	Exact treatment not stated.	Cured.
10	Mr. Hewetson. *Lancet*, 1879, ii. 81.	Marine, æt. 26. Syphilis. Symptoms noticed 2 months.	Not stated.	Esmarch's bandage applied below and above aneurism for 80 minutes; digital compression kept up for 11½ hours after.	Cured. Faint pulsation when bandage was removed; 6 hours later, no pulsation. Articular arteries felt to pulsate after the consolidation.
11	Mr. S. Jones. *Lancet*, 1880, i. 289.	Not stated.	Not stated.	Esmarch's bandage applied for 1 hour, and followed by digital compression.	Cured.
12	Mr. Croft. *Lancet*, 1880, i. 289.	Male, æt. 36. Syphilis. Symptoms noticed 10 weeks.	Not stated.	Esmarch's bandage up to and above aneurism 1 hour; followed by digital compression 2½ hours.	Cured.
13	Mr. Goodsall, *Lancet*, 1880, i. 770.	Porter, æt. 30. Produced by a strain.	Aneurism 2 in. in diameter.	Rest in bed and low diet 6 days. Esmarch's bandage up to and above aneurism, with the tubing 3 hours; then upper part removed and a tourniquet applied to femoral artery for 1 hour.	Cured. Articular arteries were subsequently felt to pulsate.
14	Mr. Rivington. *Lancet*, 1880, ii. 608.	Soldier, æt. 44. Syphilis. Pain felt 2 months.	Aneurism size of a large orange or shaddock; it felt solid.	Esmarch's bandage and strap 1 hour. Digital compression 3 hours.	Cured.
15	Mr. C. Macnamara. *Lancet*, 1881, i. 539.	Fishmonger, æt. 32. Symptoms noticed 3 weeks.	Aneurism size of a hen's egg.	Esmarch's bandage applied up to and above aneurism 55 minutes: digital compression 1 hour; genuflexion. Esmarch's bandage re-applied, 5 days later, for 1 hour; digital compression 2½ hours, followed by genuflexion.	Cured. Slight pulsation felt after the digital compression at first sitting, none after the second sitting.
16	Mr. S. Jones. *Br. Med. Jour.* 1877, ii. 562.	Dairyman, æt. 31. Pain felt for 2 months.	Aneurism size of a cricket ball; walls seemed to be very thin and pouched in places.	Esmarch's bandage below and above tumour 65 mins; Carte's compressors on artery 4½ hours, followed by digital compression 4¼ hours, no pulsation felt; digital compression 3¾ hours longer. Next day slight pulsation, digital compression 5 hours, subsequently aneurism pulsated freely, but was much firmer than at first. Esmarch's bandage re-applied for 50 minutes, and digital compression 5 hours 10 minutes.	Cured. After first sitting "the collateral circulation" was felt on inner and outer sides of knee.
17	Mr. Croft. *Br. Med. Jour.* 1880, ii. 15.	Retired soldier, æt. 34. Syphilis. Symptoms 5 months	Size of a full-sized orange, fluctuation, pulsation free.	Rest in bed, milk diet with meat, iodide of potassium. Esmarch's bandage up to and above tumour 1 hour, digital compression 4 hours.	Cured. No pulsation felt after two hours' digital compression. Death subsequently from innominate aneurism.
18	Mr. J. Hutchinson. *Clinical Soc. Trans.* xii. 55.	Gentleman, æt. 26. No history of syphilis. Pain 3 months. Pulsating tumour 3 weeks.	Aneurism filled the ham, pulsation strong and visible, loud bruit.	Rest in bed 6 days; comparative abstinence from fluids. Esmarch's bandage applied firmly below and above tumour, and lightly over it, and tubing around thigh, then bandage removed, tube removed after 70 minutes, horseshoe tourniquet applied to artery for 9 hours.	Cured.
19	Do. do.	Artilleryman, æt. 41. Syphilis. An aneurism in calf 2 years before, cured by compression. Symptoms 2 weeks.	Aneurism as large as an orange, rapidly increasing.	Esmarch's bandage applied as above 1 hour; interrupted instrumental compression 12 hours; no benefit. Four days later Esmarch's bandage re-applied nearly 2 hours, followed by digital compression 11 hours.	Cured.
20	Do. do.	Not stated.	Not stated.	Dry diet; iodide of potassium. Esmarch's bandage as above; digital compression some hours	Cured.

No.	Name of Surgeon and Reference.	Clinical History.	Characters of Aneurism.	Treatment.	Result.
21	Mr. C. Heath. *Clinical Soc. Trans.* xiii. 151.	Coal miner, æt. 32. No history of syphilis. Pain 10 weeks. Rigidity of brachial artery.	Aneurism size of a hen's egg.	Genuflexion for six hours, no result. Esmarch's bandage above and below aneurism and tubing round thigh 3 hours; Carte's compressors 14 hours.	Cured. No pulsation when bandage was removed; 1 hour later slight pulsation, compression then begun. Anastomosing arteries around knee enlarged.
22	Mr. C. Heath. *Clinical Soc. Trans.* xiii. 151.	Potman, æt. 37. No history of syphilis, a free drinker; no sign of arterial degeneration; symptoms 2 months.	Aneurism rather larger and softer than the above, oval in shape, fusiform (?).	Esmarch's bandage applied as above 3½ hours—no effect. Carte's compressors ineffectually applied. Digital compression 3 hours; pulsation much lessened; flexion 6½ hours; pulsation still forcible; flexion 4 hours; Esmarch's bandage 3½ hours; flexion 6 hours.	Cured. After second sitting the aneurism was much harder, and presented only slight pulsation, which had disappeared next day. An enlarged artery felt on inner side of patella.
23	Dr. O. Bloch, of Copenhagen, Hospitals—Tidende, 1877.	Traumatic.	Not stated.	Esmarch's bandage and tube 1 hour; Carte's compressors 1 hour, followed by digital compression of artery 5½ hours.	Cured.
24	Dr. Freeman. *New York Med. Jour.* xxxi. 638.	Not stated.	Not stated.	Esmarch's bandage up to, lightly over, and firmly above aneurism 80 minutes, followed by digital compression 65 min.; following day some pulsation digital compression again 3½ hrs.	Cured.
25	Dr. T. T. Sabine. *New York Med. Jour.* xxxi. 638.	Not stated.	Not stated.	Esmarch's bandage 75 minutes; Horseshoe tourniquet 2¼ hours; pulsation returned next day and increased. Esmarch's bandage re-applied for 3½ hours, followed by horseshoe tourniquet for 3½ hours.	Cured.
26	Mr. M. Baker. St. Bart. Hosp. Rep. xv. 75.	Male, æt. 40. No history of syphilis; symptoms 7 months	Tumour filled the ham; pulsation faint, due to a leakage of blood from the sac.	Esmarch's bandage 35 minutes; compression of femoral artery 25 minutes—no improvement. Four days later bandage re-applied below and above tumour 65 minutes; digital compression 50 minutes; bandage 35 minutes; digital compression 85 minutes; next day swelling in ham was large, soft, and fluctuating, but no pulsation in it.	Cured.
27	Mr. Manifold. *Lancet*, 1878, i. 86; and Mr. Chauncy Puzey *Lancet*, 1879, ii. 575.	Dock labourer, æt. 34. Pain 16 days.	Aneurism size of orange.	Esmarch's bandage applied as high as, then lightly over, and firmly above, the tumour, and tubing affixed; retained ¼ hour, tourniquets 4 hours longer. Two days later bandage re-applied for ¼ hour; next day genuflexion.	Tumour became firmer during first sitting, but pulsation was not abolished until after continuous genuflexion; he was then discharged "cured." Admitted to hospital 15 months later with history of pain, numbness, stiffness of joint and pulsation during the whole of that time. Aneurismal tumour distinct; cured by instrumental compression.
28	Mr. Thornton. *Lancet*, 1879, ii. 238.	Soldier, æt. 37. No history of syphilis or alcoholism. Symptoms of 3 months' duration.	Aneurism measured 3 by 2 in., very expansile, with full pulsation.	Esmarch's bandage and tube applied so as not to stop all pulsation in the tumour, and in combination with Signoroni's tourniquet.	Cured.

No.	Name of Surgeon and Reference.	Clinical History.	Characters of Aneurism.	Treatment.	Result.
29	Dr. Derr, *N. Y. Med. Rec.* No. 573, p. 485.	Male, robust.	Large aneurism.	Esmarch's bandage applied for 45 mins.: pulsation lessened: 4 days later bandage reapplied for 85 mins.: pulsation still less forcible: 3 weeks later bandage reapplied 1 hour; digital compression, 6 hours; tumour much firmer and smaller; digital compression repeated several times.	Cured.
30	Dr. R. F. Weir. *Arch. of Med.* April, 1880, p. 210.	Negro, æt. 38. Phthisis. Symptoms 4 months' duration, following a strain.	Aneurism larger than the closed fist, pulsation free, with loud sharp bruit.	Esmarch's bandage up to and above tumour, and elastic cord, 2 hours 35 minutes; then cord only removed and Signoroni's tourniquet applied for 1 hour 50 minutes; pulsation then abolished, recurred next day. Bandage and tube re-applied for 2 hours 50 minutes, and bandage only for 4 hours longer, followed by Signoroni's tourniquet ½ hour, no pulsation. Collapse and death 27 hours later.	Death.
31	Mr. M. Bradley. *Br. Med. Jour.* 1876, ii. 571 and 767.	Patient, æt. 35. No history of syphilis. Symptoms 7 weeks.	Aneurism size of an orange.	Rest in bed with Carte's tourniquets for 3 days; then Esmarch's bandage, leaving the whole ham uncovered 50 minutes; no effect. Carte's tourniquets applied for a week. Then Esmarch's bandage, as before, for 65 minutes.	Not cured. Subsequently cured by ligature of the femoral artery.
32	Dr. Campbell. *Lancet*, 1878, i. 86.	Fireman, æt. 39. Well-marked atheroma of other arteries.	Aneurism size of orange.	Esmarch's bandage up to, lightly over, and firmly above the tumour, retained for 50 minutes, followed by tourniquets for some time; repeated 3 times.	Not cured. Subsequently cured by ligature of the femoral artery.
33	Mr. Barwell. *Lancet*, 1878, i. 123.	Soldier, æt. 49. History of syphilis and alcoholic excess; chronic rheumatism, and phthisis, marked dilatation and atheroma of arteries. Symptoms 13 months.	The aneurism formed a large fusiform tumour, 3 by 2 in.	Esmarch's bandage from toes up the thigh; 70 minutes; no effect; 3 days later repeated for 5 hours; the aneurism was then solid, but pulsation soon returned to same extent as before.	Not cured. Subsequently cured by ligature of the femoral artery.
34	Mr. H. W. Page. *Lancet*, 1878, i. 414.	Carman, æt. 28. No other disease; pain noticed 1 month.	Not stated.	Esmarch's bandage up to and above aneurism 90 minutes; gentle manipulation of the aneurism; subsequently, a tourniquet to control, but not to arrest arterial flow; the aneurism became firmer. The application of the bandage was repeated for 1 hour; the tumour was then firmer, and the pulsation less marked and more distant; the bandage again applied for an hour; after this the aneurism increased in size.	Not cured. Ligature of femoral artery was subsequently successful.
35	Mr. James Lane *Lancet*, 1878, i. 682.	Carman, æt. 28. No history of syphilis nor alcoholic excess. History of a slip 2 months before; pain for 3 weeks.	Aneurism the size of a small orange; pulsation not well marked.	Three days' rest in bed. Esmarch's bandage applied "in the usual manner" for 1 hour; followed by digital compression of the artery for 1 hour, and afterwards a tourniquet. Pulsation, with all its original force, was observed quickly after.	Not cured. Subsequently cured by ligature of the femoral artery.
36	Mr. Barwell. *Lancet*, 1878, ii. 880.	Arteries atheromatous, and a fusiform aneurism of axillary artery, albuminuria, phthisis.	Aneurism fusiform.	Esmarch's bandage applied up to and above aneurism, which was protected by a tin plate; retained 1½ hour each time for six sittings. No mention of subsequent compression of artery.	Not cured. Subsequently cured by ligature of femoral artery.

No.	Name of Surgeon and Reference.	Clinical History.	Characters of Aneurism.	Treatment.	Result.
37	Mr. Bryant. *Med. Times & Gazette*, 1878, vol. ii. 101.	Male, æt 45. No history of syphilis; lump noticed 5 weeks.	Aneurism as large as an apple; rapidly growing, soft.	Esmarch's bandage up to and above aneurism for 3 hours; sac was then firmer, the pulsation altered, but in 3 days all improvement had disappeared. Bandage was repeated, and with the same result.	Not cured. Subsequent ligature of femoral artery; gangrene of foot fourth day after operation.
38	Mr. Bryant. *Trans. Internat. Med. Congress*, 1881, vol. ii. p. 221.	Male æt. 45.	Not stated.	Esmarch's bandage 1 hour; no change.	Not cured. Cured by ligature of the femoral artery.
39	Mr. Bryant, *Trans. Internat. Med. Congr.*, 1881, vol. ii. p. 221.	Male, æt. 42.	Not stated.	Esmarch's bandage applied firmly 30 mins.; more loosely 80 mins.	Not cured. Cured by subsequent ligature of femoral artery.
40	Mr. Norton. *Lancet*, 1878, ii. 880.	Cardiac and arterial disease. Two femoral aneurisms on opposite sides.	Not stated.	Exact method not stated.	Not cured.
41	Mr. T. Smith. *Lancet*, 1879, ii. 121.	Soldier, æt. 48. History of syphilis. Cardiac disease. Symptoms noticed 8 months.	Not stated.	Esmarch's bandage up to and above aneurism for 1 hour; then digital compression 15 minutes, and tourniquets 2¼ hours; the bandage again applied for 1½ hours, and followed by tourniquets; the tumour felt solid, but pulsation returned in a few minutes. Bandage re-applied for 1½ hours; tourniquets, 1½ hours; the pulsation returned next morning, and the tourniquet was tightened for 3 hours, but without permanent result.	Not cured. Subsequent ligature of femoral artery. Death.
42	Mr. E. Bellamy. *Lancet*, 1880, i. 248.	A discharged soldier, æt. 39. History of syphilis and rheumatic fever, a moderate drinker. Symptoms 9 days.	The aneurism as large as a pigeon's egg, rapidly getting larger, sac very thin.	Esmarch's bandage applied for 30 minutes at a time, every 4 hours, for 4 days; no clot, tumour larger, pulsation greater, sac thinner.	Not cured. Cured by ligature of the femoral artery.
43	Mr. E. Bellamy, Internat. Med. Congr., 1881. "Abstracts," p. 246.	Not stated.	Not stated.	Not stated.	Not cured. Subsequently cured by ligature of femoral artery.
44	Mr. E. Bellamy, Internat. Med. Congr., 1881. "Abstracts," p. 246.	Not stated.	Not stated.	Not stated.	Not cured. Subsequently cured by ligature of femoral artery.
45	Mr. T. Smith. *Lancet*, 1880, i. 289.	Not stated.	Not stated.	Esmarch's bandage and cord 1 to 1½ hours, varied with tourniquet.	Not cured. Subsequently ligature of femoral artery.
46	Mr. T. Smith. *Lancet*, 1880, i. 289.	Not stated.	Not stated.	Esmarch's bandage and cord 1 to 1½ hours, varied with tourniquet.	Not cured. Femoral artery ligatured.
47	Mr. T. Smith. *Lancet*, 1880, i. 289.	Not stated.	Not stated.	Esmarch's bandage and cord 1 to 1½ hours, varied with tourniquet.	Not cured. Femoral artery ligatured.
48	Mr. T. Smith. *Clin. Soc. Trans.* xi. 51.	Stevedore, æt. 43.	Aneurism as large as a fist, pulsation very forcible, bruit loud.	Digital compression of artery—no effect. Ligature of femoral artery with catgut, softening of ligature—no effect on aneurism. Esmarch's bandage applied for 50 minutes; tourniquet for 1½ hours.	Not cured. Subsequently cured by the application of a silk ligature to the femoral artery.
49	Mr. C. Heath. *Clin. Soc. Trans.* xi. 49.	Engine-driver, æt. 36. No history of syphilis. Arteries somewhat tortuous. Pain noticed 8 weeks, pulsation 10 days.	Aneurism filled the ham; a shrill rough murmur.	Carte's tourniquets 5 hours and 4½ hours. Esmarch's bandage 2¼ hours, tourniquets 4 hours. Next day pulsation strong, tourniquets 5 hours 50 minutes. Next day Esmarch's bandage 2¼ hours, and tourniquets 2 hours; followed by repeated and long applications of genuflexion and instrumental compression.	Not cured. Success followed ligature of femoral artery.

No.	*Name of Surgeon and Reference.*	*Clinical History.*	*Characters of Aneurism.*	*Treatment.*	*Result.*
50	Dr. Markoe. "Records," Roosevelt Hosp.	Spontaneous.	Not stated.	Esmarch's bandage up to, lightly over, and firmly again above tumour, retained for 2 hours. No subsequent compression.	Not cured. Subsequent successful ligature of femoral artery.
51	Mr. Maunder. *Lancet*, 1878, ii. 880.	Not stated.	Not stated.	Exact method not stated.	Not cured. Subsequently cured by ligature of femoral artery.
52	Mr. Maunder. *Lancet*, 1878, ii. 880.	Traumatic.	Not stated.	Exact method not stated.	Not cured. Subsequently cured by digital compression.
53	Mr. O. Pemberton, *Trans. Internat. Med. Congr.* 1881, vol. ii. p. 222.	Male, æt. 45. Disease 12 months.	Not stated.	Esmarch's bandage up to and above aneurism, and elastic tube 1 hour; pulsation almost ceased; compression of femoral artery 20 hours.	Aneurism consolidated; gangrene of leg; amputation death.
54	M. Sée, *Bull. et Mém. de Soc. de Chir. de Paris*, 1880, p. 576.	Not stated.	Not stated.	Exact method not stated.	Not cured.
55	Dr. Madelung, *Berlin. Klin. Wochensch.* 1879. No. 41.	Male, æt. 57. Symptoms 2½ years. No atheroma.	Very large, filled ham.	Digital compression twice a day for 10 days. Then elastic tube round thigh 25 minutes. Five days later elastic bandage from toes to middle of thigh, loosely over aneurism, repeated daily for 13 times for 30 to 40 minutes each time. Aneurism much smaller; pulsation still forcible.	Not cured. Subsequently cured by rod compression of femoral artery.

ANEURISMS OF FEMORAL ARTERY.

No.	Name of Surgeon and Reference.	Clinical History.	Characters of Aneurism.	Treatment.	Result.
56	Dr. R. F. Weir, *New York Med. Journal*, xxix. 520.	Idiopathic, of a few weeks' duration.	Femoro-popliteal. Aneurism as large as doubled fists; walls thick, pulsation feeble.	Elastic tubing only, applied to thigh for 90 minutes, followed by Signoroni's tourniquet for 2¾ hours; pulsation was then abolished, but returned feebly next day; the tube was then reapplied, for 1 hour, and Signoroni's tourniquet for 16 hours; but it failed. Esmarch's bandage was then applied below and above aneurism, and the tube fastened above for 2½ hours; Signoroni's tourniquet 2½ hours; and Nicaise's elastic tourniquet for 5 hours; there was no ill effect, and cure took place.	Cured.
57	Mr. T. Wright. *Lancet*, 1877, i. 163.	Fitter, æt. 39. History of syphilis; aneurism attributed to a blow. Symptoms 6–7 months.	Aneurism size of an orange, in Hunter's canal.	Restricted diet. Carte's compressor and shot bag compression—no relief. Then Esmarch's bandage up the limb, loosely over the tumour; tubing applied and retained 2¼ hours; bandage 1 hour longer. Shot bag on femoral artery for 5 days.	Cured. Slight pulsation was detected in aneurism for 4 days after sitting.
58	Mr. Hutchinson. *Clinical Soc. Trans.* xii. 55.	Not stated.	Not stated.	Dry diet and iodide of potassium. Esmarch's bandage up to, lightly over, and firmly above aneurism, and tubing 1 hour; digital compression some hours.	Cured.
59	Dr. R. F. Weir. *Amer. Jour. of Med. Science*, lxxvii. 33.	Soldier, æt. 45. Severe pain and pulsation followed an injury from pommel of saddle.	Aneurism at apex of Scarpa's triangle, 6 in. in diameter; pulsation strong; bruit, harsh, and loud.	Esmarch's bandage up to and above aneurism, with elastic tubing retained for 93 minutes: Signoroni's tourniquet 3 hours 37 minutes, and shot bag compression for 15 hours longer.	Cured. Enlargement of anastomosing arteries detected subsequently.
60	Mr. Clutton. *Br. Med. Jour.* 1880, i. 441.	Waterman, æt. 34. History of syphilis. Symptoms 1 month.	Aneurism at apex of Scarpa's triangle, very large; sac very thin, with little or no clot: femoral artery above palpably diseased.	Esmarch's bandage was applied as high as tumour and a tourniquet placed on artery at brim of pelvis for 1 hour; bandage then removed, and tourniquet continued for a few hours; no change effected. The above treatment was repeated, the tourniquet being retained for 9 hours: the aneurism was then solid. Digital compression for 26 hours longer.	Cured. The aneurism remained free from pulsation and continued to shrink, after a few days, though free from pulsation, it contained fluid. Death occurred suddenly from rupture of an aortic aneurism.
61	Mr. F. A. Heath, *Br. Med. Jour.* 1877, i. 496.	Weaver, æt. 37. History of syphilis. Symptoms 15 mths.	Aneurism of common femoral artery.	Esmarch's bandage up to and over aneurism 1 hour; Lister's abdominal tourniquet applied to aorta 2 hours, and to common iliac artery 10½ hours; digital compression 13 hours. Esmarch's bandage re-applied, with Lister's compressor on aorta, 10¼ hours. The sac consolidated, but collapse occurred, and death, from rupture of an aneurism just above the pad of tourniquet.	Death.
62	Dr. G. Poinsot. *Bull. et Mem. de Soc. de Chir. de Paris.* 1880, 570.	Male, æt. 36. No history of syphilis or alcoholism. Tumour noticed 4 days after a strain.	A large aneurism at the apex of Scarpa's triangle	Esmarch's bandage 55 mins. followed by digital and instrumental compression; the tumour became solid but softened again; a repetition of the treatment was attended with the same results.	Not cured. Subsequently cured by ligature of the artery in Hunter's canal.
63	Dr. J. Fleming. *Br. Med. Jour.* 1877, ii. 474.	Soldier, æt. 28. Doubtful history of syphilis. Symptoms 3 months.	Femoral aneurism in Scarpa's triangle, measuring 3½ + 3½ in., pulsation very strong.	Compression of the ext. iliac artery at intervals for several days. Esmarch's bandage applied up to the aneurism for 1 hour 50 minutes, compressor on the iliac artery.	Not cured. Subsequently cured by ligature of external iliac artery.

No.	Name of Surgeon and Reference.	Clinical History.	Characters of Aneurism.	Treatment.	Result.
64	Prof. Esmarch. *Centr. f. Chirurg.* 1879. No. 5.	Male, æt. 58.	Large fusiform aneurism of each femoral artery, probably caused by pressure.	Elastic bandage up to and tube above aneurism for ½ hour 3 times a day for 14 days. No change.	Not cured. Subsequently cured by rod compression of femoral artery.
			ANEURISMS OF OTHER ARTERIES.		
65	Mr. Staples. *Lancet*, 1879, ii. 791.	Soldier, æt. 39. Symptoms 2 years.	Aneurism springing from ext. iliac artery close to Poupart's lig., 3½ in. in diameter.	Esmarch's bandage applied as high as groin, and a pad and Lister's tourniquet applied to common iliac artery. Bandage removed in 30 minutes, and the tourniquet in 60 minutes; pulsation was then feeble, and it entirely ceased next day.	Cured.
66	Mr. S. M. Bradley. *Br. Med. Jour.* 1877, ii. 810.	Male, æt. 37. Previously healthy.	Aneurism of internal circumflex artery, "clearly circumscribed at the inner edge of Scarpa's triangle."	Esmarch's bandage applied so high that the highest "turns" pressed upon the aneurism, retained for 1 hour; the tumour felt harder and was pulseless; next day pulsation returned along the outer side, and the aneurism became diffused.	Not cured. Subsequent ligature of artery, amputation, death.
67	Mr. Cornish. *Lancet*, 1878, i. 235.	Labourer, æt. 20.	Traumatic aneurism of anterior tibial artery, the size of a small hen's egg.	Esmarch's bandage applied up to, and then above, tumour, and with tubing for 1 hour; tourniquet firmly applied to femoral artery 3 hours 10 minutes, loosely applied for 3½ hours longer.	Cured.
68	Mr. Rivington. *Lancet*, 1880, ii. 608.	Labourer, æt. 58. Symptoms 6 weeks.	A very large false aneurism of anterior tibial artery, which had been opened by mistake for an abscess; the calf protruded and pulsated.	Esmarch's bandage up to, lightly over, and firmly beyond, the tumour for 1 hour; tourniquet applied to femoral artery: no effect. Bandage again applied for 1 hour 20 minutes; pulsation much less; digital compression. Pulsation and murmur entirely ceased, but gangrene supervened.	Death.
69	M. J. Debaisieux *Journ. des Sc. Méd. de Louvain*, 1877, Juin.	Male, æt. 22. Gunshot wound of arm; tumour noticed a month afterwards.	Varicose aneurism of brachial artery.	Esmarch's bandage applied twice for 55 and 60 minutes respectively: slight alteration in the size of the aneurism and the character of the bruit with temporary consolidation.	Not cured. Afterwards underwent spontaneous cure. (?)
70	Mr. S. Jones. *Lancet*, 1880, i. 289.	Not stated.	Axillary aneurism.	Esmarch's bandage applied for 1 hour, followed by digital compression.	Not cured.
71	Dr. G. A. Peters. *New York Med. Journal*, xxxi. 637.	Not stated:	Subclavian aneurism.	Distal compression (inferred to be Esmarch's bandage) applied up the limb to the aneurism for 3½ hours, on two occasions.	Left hospital apparently cured.
72	Van der Meulen, *Nederlandsch Tijdschrift voor Geneeskunde*, 1880.	Female, æt. 22. No history of syphilis or rheumatism.	Aneurism size of child's fist on upper part of brachial artery.	Esmarch's bandage up to aneurism and tubing above it 1 hour; digital compression ½ hour. No effect. Repeated next day, and again when bandage was left on 1½ hour, and digital compression continued 1 hour 50 minutes.	Not cured. Subsequently cured by the introduction of catgut into the sac.

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