The Treatment

of

Right Subclavian Aneurism

by

Preliminary Proximal Ligature

and

Subsequent Excision of the Aneurism

Thesis for the degree of M.D.

by

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The following account of a case, which came under the care and observation of the writer while acting as house-surgeon at the Cumberland County Infirmary, is condensed from notes taken at the time.

V. N., a fireman, aged 39, was admitted on March 18th, 1899.

History — Patient's attention was first attracted by a throbbing sensation or slight swelling on the right side of the neck about ten months previously but this caused him no inconvenience at first. He did not attach much importance to it. He found, however, that the swelling increased steadily, so that his right arm was becoming gradually weaker, while he had occasional twinges of pain shooting down to the fingers. These symptoms became gradually more severe. He was eventually obliged to give up work altogether.

On Admission, there was a distinct swelling visible in the right supra-clavicular space, about the size and shape of a duck's egg, pulsatile and expansive, evidently aneurismatic in character. The tumour rose above the centre of the clavicle, and pulsation could be felt below the clavicle at its outer third. There was a distinct
systolic thrill audible over the aneurism, but the external jugular vein was distended, but the cardiac sounds were normal. The vascular system seemed to be otherwise healthy.

No history of a strain could be elicited, and the patient denied having had syphilis.

Treatement by rest, compression, large doses of potassium iodide, etc., having completely failed to arrest the growth of the aneurism, the patient agreed to submit to operation. Accordingly, on the 14th of April, 1899, the ligature of the First Portion of the Subclavian was performed by Mr. H. C., assisted by the writer, after the method described by Mr. Barwell. The vessel was exposed close to the clavicle without difficulty. It was exposed to the origin of the Vertebral, as no branch was seen between the ligature and the bifurcation of the subclavian. A broad flat ligature of kangaroo tendon was used. It was easily passed under the vessel by means of a large double-curved aneurism needle. On tightening the ligature, the radial pulse was completely stopped, the aneurism partially collapsed, and all pulsation in it ceased. The wound was then closed, a sterilized gauze dressing applied.
The whole operation, from the first incision to the last stitch, occupied only 1½ minutes, and there was practically no haemorrhage or shock.

Within ten hours, a faint pulsation could be felt in the radial, and on the day following the operation, pulsation was distinct; the general condition was most satisfactory, and at no time gave rise to the slightest anxiety.

The stitches were removed at the first dressing on April 23rd, and the wound was found to have healed by first intention, but pulsation in the sac had returned, though the aneurism was smaller than before operation. On April 28th, the radial pulse was almost as large as formerly.

During the months of May, June, and July, 1879, the aneurism continued to increase in size, the arm began to waste, and there was much pain owing to pressure on the brachial plexus, so that further interference became imperative.

Accordingly, on August 4th, 1879, the first portion of the axillary artery was exposed in the interval between the pectoral and deltoid muscles, and ligatured as before with kangaroo tendon. Some difficulty was experienced in finding the vessel, the operation occupying about half an hour.
Again the radial pulse was arrested. A pulsation in the sac ceased. From August 8th faint pulsation could be detected in the radial, the shooting pain down the arm persisted. A pulsation in the sac gradually reappeared, though the sac itself had diminished in size somewhat. Healing of the wound was delayed on account of the difficulty in getting the skin to fall into the hollow left after the dissection beneath the clavicle.

The patient then insisted on going home. I was lost sight of for several months, but, by the advice of his medical attendant, he returned to the Infirmary in January, 1900. He then complained chiefly of loss of power in the right arm and hand, a pain shooting down the arm as before but much more intense. The loss of power was marked, as the hand could not grasp anything, nor could the fingers be closed upon an object resting in the palm. Marked muscular wasting in the upper arm and forearm was also evident.

The supraclavicular space was occupied by a pulsating swelling, forming a distinct protrusion about 4 inches in length and 3 inches in depth. By deep pressure on the upper 1/3 inner part of the aneurism, pulsation in the sac could be
controlled. It almost obliterated. There was no alteration in the skin over the aneurism, if the clavicle, though somewhat displaced, was not adherent. But the sac was evidently pressing backwards against the brachial plexus, as well as forwards against the clavicle. There was, however, no evidence of extension into the axilla.

As the man's condition was rapidly becoming worse, it was decided to attempt extirpation of the sac. To this the patient readily gave consent, after the facts of the case had been explained to him. On January 21st, 1900, this operation was therefore undertaken. The clavicle was exposed and bared for some 4 or 5 inches, 1 1/4 inches of the middle of outer third sawn away, after first passing a copper retractor underneath. The posterior surface of the bone required careful separation from the wall of the sac. The latter was thus fully exposed, and was seen to be fed by a large vessel at its upper inner side, which passed from behind the Scaenus Anticus almost perpendicularly downwards and forwards to the sac.

After this vessel had been divided between two ligatures, the aneurism shrank to about the size of a hen's egg, 4 it was then dissected away.
from the proximal towards the distal end, the efferent vessel being finally tied with kangaroo tendon. The operation was not a difficult one. A comparatively little blood was lost, as all vessels cut were first ligatured, or immediately secured by pressure forceps. The cords of the tracheal plexus gave no trouble. The subclavian vein was not seen; but it was found necessary, in the course of the operation, to make an additional incision up the neck at right angles to the first, to turn back the flaps, in order to obtain free access to the aneurism. The excised portion of the clavicle was not replaced, and the whole operation was completed in about 4½ minutes.

The operation chanced to be straightforward and practically devoid of complications, the only important structures divided being the external jugular vein and the omohyoid muscle, whilst the feeding vessel was found at the place where it was believed, before operation, to enter the sac.

The Aneurism:—On slitting up the sac after removal, no vestige of clot was to be seen, but atheromatous patches were visible in the walls.

As an interval of 9 months had elapsed between ligature of the subclavian and the extirpation, it
is not to be wondered at that no trace of the subclavian artery was found on the outside of the aneurism. The feeding vessel, which was about the size of a quill, could not be identified with certainty. The posterior surface of the excised portion of the clavicle was considerably worn. It would ultimately have given way at this point in all probability, if the patient had survived long enough.

The radial pulse was thus obliterated for the third time, but on January 25th an extremely faint pulsation could be detected. If the numbness in the hand had not only disappeared, but the fingers could be bent if the patient could grip fairly well, while the shooting pain had entirely gone. On the 24th a sphygmographic tracing of the radial showed a slight undulating line. On the 27th the pulse could be counted.

During this time, the return of power in the hand and fingers was very marked. By the 5th of February an object could be firmly grasped. The wound healed without trouble, and the general condition never gave rise to the slightest anxiety.

Condition on Discharge:—When the patient left the Infirmary in the beginning of March, all
the movements of the arm could be performed except elevation of the upper arm above the shoulder. The divided ends of the clavicle had approximated one another considerably, but were not on the same level, the outer portion having been drawn upwards. The shoulder had fallen forward somewhat, but this was not very noticeable.

Subsequent Progress:In June, 1902 (i.e., about 2½ years after the last operation), the man presented himself for inspection. I reported that he had no pain, that he had been at work for 15 months, did all his work as formerly with the right arm, earned the same wages as before. I had not lost a day since he recommenced work. His muscular condition was good, the heart's action normal in every respect. I there was no sign of enlargement. The two ends of the divided clavicle were about 1½ inches apart. I had been drawn upwards to some extent. He could raise the right arm to the same height as the other. The right radial pulse was very small as compared with the other.
General Remarks:— The condition of the patient, when he presented himself for the third time, rendered it absolutely necessary that something should be done to relieve his sufferings, and also (if possible) to restore the use of the arm, as the man was suffering intensely, he was quite unable to work or do anything to earn his living, and indeed, a painful lingering death seemed to be his only prospect. The ligation of the first portion of the Subclavian had proved to be of only temporary service, while the ligation of the Axillary had been even less effective. The question therefore arose—what more could be done? Extirpation of the sac seemed to be the only course which offered any prospect of immediate and permanent relief. A encouragement was derived from the success attending a similar case, under the care of the late H. W. Allingham, in which the sac was excised 38 days subsequent to ligation of the Subclavian. His case appears to be the first on record in which this procedure was adopted. A careful search of all the literature relating to the operative treatment of Subclavian Aneurism reveals no other case (except the one here described) in which preliminary ligation, followed by
cotperation has been employed, though simultaneous
digation & cotation has been successfully
performed on at least two occasions — by Schopf, on
the right side, & by Halsted, on the left.

Advantages of the Operation: — It would, of
course, be dangerous to build too much upon
the results of two cases only, but the experience
gained in the case already described fully
warrants the conclusions put forward by Mr.
Allingham in reporting his case, viz.:

"The ligature of the first portion of the main
vessel was followed by distinctly good results,
limited though these were, to a hardening of the
aneurism & diminution in its pulsation. It
is interesting, also, that the procedure was not
followed by secondary haemorrhage, as is supposed
to follow on ligature of the subclavian artery.
As there was no prospect that pulsation would
cease altogether, the difficult & severe expedient
of removal was resorted to, 5½ weeks after the
preliminary operation. Here it may be recorded
that the hardening, and, if one may so put it,
the better definition of the tumour brought about
by a previous ligature of the subclavian, rendered
the complete removal easier & more expeditious.
than if a soft thin-walled sac had had to be dealt with, in addition to the probability that,
had rupture accidentally occurred during manipulation,
loss of blood would have been less excessive, owing
to the small calibre of the channel through the
aneurism.

2. The preliminary ligature had caused the
collateral anastomosing channels to become so active, that fear of gangrene was at no time
entertained.

3. Removal of the greater part of the clavicle is
necessary in such cases, access to the sac & to the
vessel below being impossible without this
operation.

The excellent outcome of this case warrants
the putting forward of the treatment adopted as
worthy of consideration in similar cases. I should
the question of removal of the sac be entertained,
I believe, for the reasons indicated above, that
preliminary ligature of the main vessel on the
cardiac side will go far to ensure success. That
the risk of the occurrence of gangrene was minimised
by the establishment of the free collateral circulation
is evident, although the subclavian vein was
wounded & partially occluded.
It may be noted that, in Allingham's case, the patient's age was 25; the aneurysm was the size of a tangerine orange, a V-shaped incision was employed, the ligature was applied external to the origin of the Vertebral, while the operation lasted two hours, owing to the trouble experienced with the brachial pulse and subclavian vein.

It may be objected that the procedure here advocated subjects the patient to two severe operations, where one (i.e., simultaneous ligation and excision) would suffice, but this objection seems to be fully answered by Allingham's remarks, for if the patient is fit and willing to submit to two operations, the risks are diminished and the chances of recovery increased thereby. Moreover, as proximal ligation alone has effected a cure in at least one case (that of Green, though here the third portion of the subclavian was tied), I would probably have done so in others under modern aseptic conditions, it seems only right that it should be tried before proceeding to the more serious task of extirpation as well. At the same time, it might be well to approach the operation with an open mind on this point, and be guided by circumstances as to whether one
should be content with preliminary ligation alone, or, if the conditions are favourable, go on to perform exsirpation at the same time.

Walsham, speaking of the treatment of aneurisms in general by exsirpation, arrives at the following conclusions from an analysis of 33 cases so treated:

"Three chief methods of exsirpation were employed:

1. The old method of laying open the sac, turning out the clots, & ligation the artery above & below.
2. The same operation plus removal of the sac by dissection.
3. Removal of the sac after the artery had first been tied above & below.

The last method, slightly modified, as in my own case & four others, I would submit, is the ideal way of exsirpating an aneurism. For, after two ligatures have been applied to the artery on the proximal side of the artery has been divided between them, the aneurism, which remains full of blood & retains its form, can be more readily dissected up from its deep connections than when the sac has been previously opened. At each step of the dissection can be clearly seen, since the ligature on the stump of the vessel entering the
sae prevents the sac collapsing. By working round the sac from the proximal towards the distal end, the distal artery is more readily discovered than by searching for it at the distal part of the sac, with less disturbance of parts, or any large secondary branches that may enter the sac are easily found in the course of the dissection, I can be promptly secured.

"The aneurisms for which extirpation would appear to be most suitable are these:

1. Where there is insufficient room to apply a ligature on the proximal side, or where a proximal ligature is attended with great risk, as in ligature of the common femoral.

2. Where a number of large vessels communicate with the sac.

3. Where other methods have failed to cure the aneurism.

4. Where the aneurism, as in the popliteal artery, has become diffused, or rupture of the sac or gangrene of the limb is threatened.

5. Where the setting free of emboli, as in carotid aneurism, would be attended with risk of cerebral softening.

Partly, the extirpation of an aneurism in a
"Suitable case, versus ligature of the proximal or distal artery, holds out the further advantage that, inasmuch as the whole aneurism is got rid of, the cure is radical. All risk of recurrent pulsation, secondary hemorrhage, inflammation & suppuration of the sac. Later, cicatricial contraction with consequent involvement of the nerve trunks & the impairment of the mobility of joints, is removed. From a review of the cases, & from the experience gained in my own, I think it is shown that the operation of excision, although no doubt a more formidable one that simple proximal ligature, may, if all modern surgical precautions are taken, be looked upon as a most successful method of treating an external aneurism. It is perhaps the best that can be adopted for the conditions that have been mentioned. Such a view, however, hardly supports the contention of those surgeons who advocate that the excision of an aneurism should be the routine treatment."

Kubler has also collected 40 cases of aneurism of all kinds treated by excision of the sac, 39 of which were successful. There can be
little doubt that this method is gradually establishing itself as the ideal method of treatment in suitable cases. Such cases are, however, comparatively limited. If I submit that Mr. Allingham's case + the one I have described, may together be looked upon as extending the applicability of the treatment by extirpation to certain cases of subclavian aneurism hitherto regarded as inoperable in this manner, if the preliminary proximal ligation be adopted, because the preliminary ligature certainly tends to diminish the size of the aneurism for some time at least; it hardens & defines the tumour, thereby decreasing the risk of handling it during the subsequent removal; & by allowing the establishment of a free collateral circulation, it not only avoids all risk of gangrene, but affords this collateral circulation an opportunity of "settling down", as it were, in its new channels, & thus diminishes the risk of further circulatory disturbance when the removal of the growth itself is performed.

These points may make all the difference between ultimate success & failure. Because, granting that the radical cure by extirpation is the best & most rational line of treatment,
it follows that any procedure which diminishes the risks and lessens the difficulties of such removal, must tend to increase the chances of success. Especially in cases of large thin-walled aneurisms, where simultaneous ligation would be both difficult and dangerous, the preliminary ligation may make the removal not only less dangerous but comparatively easy.

Risks attending the Operation of Ligature of the Subclavian in its first portion: It may fairly be claimed that this operation is less dangerous than simultaneous ligation of, e.g., the Innominate, Common Carotid, and Vertebral, as recommended and practised by some of the older surgeons, but it is certainly less likely to cause cerebral symptoms or gangrene, because there is less interference with the circulation.

I advance this claim with all respect for the weighty opinion of Mr. Jacobson, who says: "It seems most doubtful whether the improvements of modern surgery, aided by recently introduced ligatures, will ever render this a successful operation, failing as these advantages almost certainly will, to meet that secondary hemorrhage which has proved so
"fatal from the distal side of the ligature, owing to the facility with which the numerous collaterals bring in blood to this spot. Dr. J. E. Ericson, who gives what he calls an "appalling" table of 14 cases, all fatal, condemns the operation as "bad in principle" and "most unfortunate in practice." He considers that it should be "banished from surgical practice."

Mr. Jacobson then proceeds to describe in detail the method of performing the operation "for practice on the cadaver." Trues also states that the operation has never been successful and should not be practised. Yet here are two cases recorded, in which there was not at any time the slightest sign of secondary haemorrhage, and one may reasonably ask whether its former frequency was due to the reason given by Mr. Jacobson, or to — sepsis. Nevertheless, the operation is not one to be lightly undertaken.

It may be parenthetically remarked here that neither this nor any other form of operative treatment should be attempted until palliative methods have failed. Thus, Poland records that of 14 cases treated by Valsalva's method, 50 per cent. recovered, 4 of 5 cases treated by
direct pressure alone, 80 per cent. recovered; but of 35 cases where no operative measures of any kind were employed, 65 per cent. died.

Leaving out of the question the difficulties that may be encountered during the operation, such as trouble in finding the vessel, or in passing the ligature, or injury to other structures, the chief risks connected with the operation hitherto have been gangrene & secondary haemorrhage. As regards the first of these, it is only necessary to refer again to Mr. Allingham's remarks on his own case in this connection. As regards the second, the possibility may be dismissed equally briefly by stating that, in the vast majority of cases, secondary haemorrhage will be avoided by strict attention to asepsis as relating to the ligature & the general conduct of the operation. There can be little doubt that un-sterilized ligatures have been the cause of most of the cases of secondary haemorrhage which have so frequently proved fatal after this operation. If we now know that the too free detachment of the sheath, or the condition of the vessel wall itself, or the amount & kind of clot formed (all of which
have been described as causes of secondary hemorrhage) have comparatively little effect in producing it.

Similarly, suppuration in the sac was variously ascribed to a disease condition of the vessel-wall, or to the irritation set up by the ligature itself, whereas the real cause was sepsis. As a matter of fact, a disease condition of the vessel-wall does not necessarily preclude successful ligature, because the ligature (if absolutely sterile & of suitable material) is gradually organized & absorbed, & thus actually strengthens the vessel instead of causing secondary hemorrhage or suppuration in the sac. Nor can it be predicted with any degree of certainty that the vessel is less likely to be diseased at a distance from the aneurism than in close proximity to it, hence there is not at the present day the same anxiety to apply the proximal ligature at some distance above the sac, as was manifested formerly “to avoid irritation in the neighbourhood of the sac.” In fact, the Hunterian method is rather to be avoided in certain cases, as, for instance, where the aneurism is very large or has become diffuse, because the
size of the clot formed may be so large as to press on the branches of the main vessel, thus seriously interfere with the collateral circulation.

The method of ligature close to the sac accompanied or followed by extirpation, is certainly to be preferred in such cases, because the danger of gangrene is thereby greatly diminished, if not entirely eliminated, since there is more chance of the establishment of a free collateral circulation if a probable cause of interference with it is removed.

The ligature itself requires some consideration. The material used must fulfill certain conditions—it should be soft, pliable, non-irritating, of such a nature that it will be gradually but not too quickly absorbed. Floss silk has been successfully used. I recommended by some surgeons on account of the certainty with which it can be sterilized, the ease of manipulation, and the security with which the knot can be tied, but it acts more or less as a foreign body and is too slowly (if at all) absorbed. Catgut is recommended for Penn, but requires great care in preparation and is difficult to sterilize. Kangaroo tendon was used in the case I have described. It proved entirely satisfactory in every respect. In another case at
which I assisted, where the Common Carotid and Subclavian were ligatured for Innominate aneurism, with a fatal termination twelve months afterwards, the vessels were found to be entirely occluded at the seat of ligature—no trace of the Brangroston tendon could be found. While in a third case (at which also I was fortunate to assist) of a huge aneurism involving the Aorta, Innominate, or parts of the Subclavian & Common Carotid, where the patient died 16 hours after the operation of cerebral anaemia, it was found that the ligature of Brangroston tendon on the Subclavian was so close to the aneurism as to be practically embedded in it, but it was holding well, & so also was the one on the Common Carotid. The walls of both vessels were very thin & in some places calcareous, but the ligatures did not appear to be "eating in" at all—& from a personal experience of a total of 9 cases where this material was employed, I can recommend it as entirely fulfilling the required conditions in every respect.

The force with which the ligature should be applied has been the subject of elaborate experiments by Ballance & Edmunds. 12 & these experiments confirm the conclusions already arrived at by most surgeons,
viz., that the coats of the artery should not be ruptured. The continuity of the vessel is thereby maintained, the danger of secondary haemorrhage greatly diminished, the nearness of a collateral branch may be practically ignored, and the presence of atheroma comes to be of secondary importance, though of course, its absence increases the prospects of success. These observers have shown that when a ligature is applied to a large vessel, such as the Subclavian, with sufficient force to bring the surfaces of the internal coat into contact, but without rupturing the middle or external coats, the resulting proliferation of endothelium will entirely occlude the lumen of the vessel, while its wall remains entire and offers a firm resistance to any tendency towards secondary haemorrhage. The exact amount of force required to produce these conditions can, of course, be arrived at only by experience in actual practice, and depends upon the size of the artery concerned, as also upon the condition of its walls. The same authors have also shown that the use of two ligatures, with a slight interval between, diminishes the risk of rupturing the coats, and this method is undoubtedly to be preferred where there is sufficient room.
but this is not always obtainable in the case of
the Subclavian, owing to the depth at which it lies
& the difficulty of obtaining free access.

The method of tying the ligature has also been the
subject of extensive experiments by Ballance &
Edmunds, & it may be briefly stated that the
"stay-knot" described by them was the method
employed in the case I have described. I also in
the others incidentally referred to, with perfectly
satisfactory results in every case.

The interval that should elapse between the
preliminary ligature & the subsequent section,
where this method is employed, cannot be accurately
determined until other cases have been recorded. &
even then, it will probably be impossible to lay down
any hard & fast rule, because each case will
depend upon the special circumstances connected
with it; but it may be stated generally that
section may be attempted as soon as it is
certain that firm union has occurred, that the
collateral circulation has been firmly established, &
that there has been sufficient time to allow of total
or partial absorption of the ligature (provided always
that the urgency of the symptoms does not necessitate
earlier interference). Moreover, by that time, the
question as to whether or not a cure is likely to result from the ligation alone, will be decided.
In Allingham's case, the interval was 5½ weeks, in our case it was 9 months, but the latter was certainly too long, it was due to the fact that the patient refused to remain under observation.

As regards the extirpation of the sac, only one rule can be laid down with any degree of certainty, viz., that the greater portion of the clavicle must be excised in order that free access to the sac may be obtained. In other respects, each case must be a law unto itself, each will probably present special difficulties, from adhesion of the subclavian vein, brachial plexus, etc., to the walls of the sac, though none of these was present in the case described. Few cases will be so uncomplicated as this, however, and in some it may even be impossible to remove the whole of the sac, but this is not of primary importance so long as strict asepsis is maintained.

The After Treatment may also be summed up very shortly, because it consists simply in keeping the wound rigidly aseptic and in countering stiffness & weakness of the limb by warmth, massage, & electricity if necessary.
While not attempting in any way to minimise the seriousness of this twofold operation, a study of the literature relating to the previous operative treatment of aneurism of the Right Subclavian encourages one to advocate any method which promises to lessen the appalling mortality that has hitherto attended the great majority of the operations performed by even the most eminent surgeons. Fouchon," from an exhaustive study of all the cases then available, states that of 56 operated cases of idiopathic aneurism of the Right Subclavian, only 8 cases recovered (one of these being the historic case of Byrne, who also states, in a postscript to his paper, that he had subsequently performed the "old operation" with success in a case of axillary aneurism). Of 43 cases of proximal ligation of all kinds, only 8 recovered; of 8 cases of ligation of the Right Subclavian alone, all died. At the same time, as Fouchon truly remarks, "the condition of asepsis is so important that all the cases of the pre-aseptic period must be left out in all statistics and comparisons," and, after a careful analysis of all the cases enumerated by him, he comes to the conclusion that "the best plan to pursue in the future is to ligate the first portion of the Subclavian with a double, or better triple, non-contiguous, absorbable ligature without rupturing the coats."
In conclusion, as showing the trend of modern surgery, i.e., opening up a vista of possibilities which may or may not be realized, the remarks of Professor Rossier (Königsberg) on "Ideal Operations for Aneurism" at the German Surgical Congress held at Berlin in April, 1904, may be quoted. He said that an operation might be called ideal when the sac of the aneurism was successfully removed, the circulation in the vessels being at the same time preserved. He obtained an excellent result in a case of arteriovenous aneurism of the popliteal vessels by resecting both vessels & joining the divided ends. The resection left a gap of 5 centimetres between the ends, but this deficiency was supplied by means of a metallic appliance. Immediately after the operation the pulse could be felt in the posterior tibial artery; 9 months later, however, the pulse was less distinct, because the lumen of the artery was compressed by cicatrices, but no interference with the circulation had occurred. In another case of aneurism of the popliteal, a gap of 7 centimetres existed after the resection, which he tried to fill up by the implantation of a piece of the patient's saphenous vein. Circulation was at once restored, but after 5 days, the patient became delirious & died. At the necropsy, it was found
that no thrombus was present within the implanted piece.

Though not strictly connected with the subject of aneurism, it may be mentioned that, at the same Congress, Prof. Schick (Breslau) gave the results of some experiments which lend support to Professor Boeck's procedure. He succeeded in transplanting portions of arteries and veins of one mm. diameter from one animal to another, in obtaining complete union of the implanted portions without disturbance of the circulation. In a dog, he had cut the renal vessels, ligatured the central ends, and joined the peripheral ends with the iliac vessels; the implantation succeeded, and the kidney continued to secrete urine. When the dog was killed several months afterwards, no important alterations in the implanted parts were found. In the same way, he had implanted the thyroid artery of a dog into the carotid artery.
References:
13. Ibid., p. 376.
17. Ibid.