PROJECTILE INJURIES OF BLOOD VESSELS;

WITH SPECIAL REFERENCE TO ANEURYSM AND
THE INTRASACULAR OPERATION.

BY

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THE surgery of the vascular system has received considerable attention in recent years, and owing to the work of Carrel, Matas, Murphy, Halsted, and others, suturing and plastic work on blood vessels have become established as rational surgical procedures. It may be anticipated that such advances can be extensively employed in the large number of cases of vascular injuries occurring in the present war, with proportionally improved results; nevertheless, experience shows that suturing or anastomosis is applicable only in a comparatively small number of cases, and that ligation is still the most suitable operation for the majority, and will in every case effect a cure if the injury to the vessel be attacked directly by the intrasacculary route.

During the past nine months, excluding several cases of intracranial vascular injuries and some cases of ordinary secondary haemorrhage, I have operated on fourteen cases for lesions of the blood vessels. The views expressed in this paper are based upon the clinical observations and operative findings in these cases, of which the following is a summary:*

Aneurysms 10:—2 axillary, 1 brachial, 1 radial, 1 ulnar, 1 superficial femoral, 1 popliteal, 1 anterior tibial, 1 posterior tibial, 1 ascending pharyngeal; aneurysm and aneurysmal varix 1; varicose aneurysm 1; laceration of femoral vein 1; hour-glass constriction of axillary vein 1.

All cases of aneurysm and the case of varicose aneurysm were treated by intrasacculary operation. In one case (popliteal aneurysm) restorative endo-aneurysmorrhaphy was performed; in the others "trans-sacculary ligation" was necessary, although in three of them suturing operations were at first attempted, and in one of these restorative endo-aneurysmorrhaphy was actually completed before it was recognized that the case was complicated by the addition of aneurysmal varix.

There was no mortality in the series, and in every case the vascular lesion was cured.

ETIOLOGY AND VARIETIES OF INJURIES.

Projectile injuries of the blood vessels may involve an artery, a vein, or both, and may be classified as: (1) those caused by high velocity bullets, and (2) those caused by shells, including in the latter shrapnel balls, fragments of shell casings, or bombs. While the distinction is not of great importance, and it is often impossible to determine from the appearance of the vascular lesion alone by which agency it has been produced, still, on the whole, each class presents certain characteristics which are analogous to those seen in wounds of the soft tissues in general.

Rifle bullet wounds are usually clean cut, with sharp smooth edges. Owing to the punctured character of the wound in the overlying tissues (if bone is not involved), sealing off is more liable to occur, usually with the formation of a haematoma or aneurysm. A considerable number of bullet wounds heal aseptically, so that operative interference is often indicated for the vascular sequelae rather than for haemorrhage or sepsis, and may be carried out at the surgeon's leisure.

Shell wounds are usually irregular, with lacerated margins. The wound in the overlying tissues frequently gapes, with loss of substance and irregular lacerated surfaces, so that sealing off is not common, and continued bleeding, requiring immediate or early operation, often occurs. The vast majority of shell wounds are infected and suppurate, so that even if operation has not been performed for primary haemorrhage it soon becomes necessary for sepsis in many cases.

As regards the type of wound inflicted on the vessel, several varieties may be distinguished:

1. Small circular, oval, or irregular wounds involving one side of the vessel.

2. Linear or slit-like openings running in the long axis of the vessel.

3. Large gaping wounds, involving half or more of the circumference, with their upper and lower margins widely retracted from one another, suggesting actual loss of substance.

4. Through-and-through wounds, where the missile has passed right through the lumen of the vessel, producing separate wounds of entrance and exit on opposite sides of it (two cases). This is a rare type, and is very unlikely to occur in shell wounds.

5. Complete division of the vessel, with or without loss of substance. In this type the ends retract, and may be at a considerable distance from one another. This retraction is an important factor in determining natural arrest of haemorrhage, and renders this type of injury less liable to be followed by aneurysm than any of the others.

Further reference to them need not be made here, save to point out that where conservative treatment is desirable type 1 lends itself to treatment by lateral ligation or suture, according as a vein or artery is involved; type 2 may be treated by suture; type 3 will require resection and end-to-end anastomosis; type 4 may be, perhaps, rarely treated by suture, but will more often require resection and anastomosis; type 5 will require resection of both ends and anastomosis.

Frequently, however, such conservative measures will not be practicable, particularly in the latter three groups, and ligation above and below will be necessary. Indeed, where smaller vessels, such as those of the forearm or leg, are involved, and where collateral circulation is good, ligation should be the operation of choice.

ANEURYSM.

Type and Mode of Development.

One of the most important and serious sequelae of injuries of arteries is the development of aneurysm. This is always of the *traumatic* or so-called *false* variety, in which the sac is formed by the surrounding tissues. Following the injury haemorrhage occurs through the opening in the vessel, displacing the soft parts, so that a definite cavity is formed containing the effused blood, which is prevented from escaping externally by the closing in or sealing off of the wound in the overlying tissues. The aneurysm is usually of the sacculated variety, but may be occasionally fusiform when it follows complete division of an artery (two cases). The escape of blood is limited either by the clotting, which arrests the haemorrhage, or when the intrasacculary pressure becomes equal to that in the artery. Almost invariably, however, the surrounding tissues slowly yield more and more, so that in the course of time the aneurysm increases in size. The sac is at first composed of only the surrounding tissues, but these gradually become condensed by pressure and thickened by fibrosis, while a deposit of fibrin takes place on the walls. The sac usually contains soft blood clot, often being filled completely by it except around the opening in the artery. A traumatic aneurysm may follow any of the five types of wounds which have been described, although it is frequently stated that it does not follow extensive wounds, more particularly cases of complete division. The present series of cases demonstrates the inaccuracy of this, but in the latter type of injury the free retraction of the ends of the vessel renders its development less frequent.

Size.

The size of the aneurysm is determined by several factors:

1. The anatomical relationships of the wound, particularly the arrangement of fascial planes, are probably the most important. Where the vessel is surrounded by loose areolar or cellular tissue and no limiting planes of fasciae exist, little resistance is offered to the haemorrhage, which may travel widely, producing a tumour of immense size—a condition sometimes termed diffuse aneurysmal haematoma—or it may even result in rapid and fatal internal haemorrhage.

2. The type of wound in the artery appears to have some influence on the size of the aneurysm. A study of these cases suggests that, other things being equal, an aneurysm resulting from types 1 or 5 will be smaller than

* Since submitting the paper for publication 5 additional cases of aneurysm have been successfully treated by "trans-sacculary ligation"—namely, 1 profunda femoral, 1 axillary (first stage), 2 posterior tibial, 1 ulnar. Detailed records of all cases have been kept, but for purposes of publication on these have had to be omitted.

cases following types 2, 3, or 4. With either of the former haemorrhage is more gradual and a better chance of early clotting is afforded.

3. The time elapsed since injury. In all cases which were under observation for some weeks the aneurysm definitely increased in size. None showed any tendency to natural cure.

4. The size of the injured artery has very little influence; but, speaking generally, there is some proportion to be observed between the size of the aneurysm and the parent vessel, though there are many exceptions to this.

Occasionally an aneurysm shows considerable variations in size, even from day to day. It is difficult to explain this, except on the supposition that the opening in the artery, or its proximal side, becomes temporarily closed by blood clot, which after a time becomes detached and carried into the sac, thus creating an intermittent pumping action.

Time of Development.

The aneurysm usually forms soon after the wound is inflicted, haemorrhage starting immediately, so that the margins of the opening in the vessel are kept apart and healing prevented. Occasionally in cases of complete division, where the wound has closed immediately and thrombosis has presumably occurred, haemorrhage may be excited and an aneurysm formed at a later period as the result of movement or massage (one case of ulnar aneurysm). It is conceivable that this might also occur after slight partial division of a vessel, where the wound has been primarily filled with blood clot, or its margins sealed by fibrinous exudate. Consequently caution should be exercised in starting early massage or movements when the track of a missile suggests the possibility of arterial injury.

It is stated that rarely an aneurysm may form when a considerable period has elapsed by a gradual yielding and dilatation of the scar tissue which has closed the wound in the vessel.

Symptoms and Signs.

These may vary with the size and position of the aneurysm and with the contents of the sac. A general account of them may be found in any textbook of surgery, but I wish to emphasize some facts in connexion with them which are of importance in regard to diagnosis and treatment. It is convenient to divide them into (i) direct or local, and (ii) indirect or referred groups.

Direct.

(a) The tumour is firm and elastic, or even hard in consistence. This is due to the infiltration and organization which occur in the walls of the sac, and to the fact that the latter almost invariably contains blood clot. For this reason also it is not usually reducible, and attempts should never be made to test this owing to the possibility of displacing clot out of the sac and disseminating it into the parent artery or its branches. Tumour may be absent in small or deeply placed aneurysms.

(b) Pulsation is usually marked and definitely expansile, but it may be slight and of a transmitted character, or even completely absent when the sac is filled with clot. This does not mean that the aneurysm is about to undergo natural cure; pulsation will probably increase and the aneurysm increase in size while kept under observation. In some cases the pulsation may, like the size, vary much from time to time. The amount of pulsation is no indication of the type of wound in the artery.

(c) Thrill is by no means a constant sign. It occurred in only one of ten cases in the present series. When present it is systolic in time, fading away or being completely absent during diastole.

(d) The presence of a murmur is very constant. It was present in all cases in which it was investigated, and in two cases which were not diagnosed as aneurysm before operation no examination was made for it. It is definitely systolic and of a blowing character, in some cases soft, in others loud and harsh. Its intensity chiefly depends on the amount of interchange of blood that takes place between the artery and the sac; it is also somewhat dependent on the size of the vessel, and perhaps on the type of opening between the two.

Indirect.

These are due to pressure of the aneurysm on neighbouring structures or to interference with the circulation in the limb.

(a) The pulse in the distal part of the artery is diminished in volume; in some cases it is scarcely affected, while in others it is completely absent. Its condition is determined chiefly by the amount of blood which continues to flow through the artery past the aneurysm, and its absence does not indicate that collateral circulation is not well established or that gangrene is threatened.

(b) One of the most important and frequent pressure effects is involvement of nerves. With moderate pressure numbness, tingling, or neuralgic pains may be experienced in the area of sensory distribution, with paresis of the muscles supplied by the motor fibres. When pressure is severe there may be complete anaesthesia and paralysis. These pressure palsies are usually more serious than the aneurysm itself, in that they may persist long after the pressure is relieved and the aneurysm cured. The tendency to persist increases out of all proportion to the length of time the pressure has existed, and therefore constitutes an important indication for early operation. A case in which pressure has been severe and prolonged closely resembles one of complete division of a peripheral nerve, both in its clinical manifestations and its mode of recovery, and will require months of post-operative treatment.

(c) Contractures may occur in the muscles amongst which an aneurysm is situated. They are much more apt to occur in the flexor groups of muscles in the limbs, and resemble a "Volkmann's contracture" of the forearm. They are probably due to two factors: (i) An involuntary physiological contraction of the muscles in an attempt to relieve pressure and accommodate the tumour, as occurs, for example, in inflammatory torticollis; and (ii) a form of myositis induced by pressure ischaemia. The occurrence of the latter is suggested by the fact that recovery is much more gradual than in cases where simple fixation of the muscles in a shortened position has been maintained for a similar period. Their early post-operative treatment should never be neglected.

(d) Gangrene is by no means a common or likely occurrence. In none of my cases was it even threatened, either before or after operation; but it must be remembered that the patients are young men with healthy blood vessels, so that collateral circulation is readily established. The presence of infection will naturally increase the risk of gangrene.

(e) Deformity and loss of function may occur from pressure on neighbouring muscles or joints.

ARTERIO-VEINUS ANEURYSM.

Another important and not infrequent sequel of a projectile injury is arterio-venous aneurysm. It consists of an abnormal communication between an artery and a vein, as the result of a penetrating wound which involves both vessels. Two varieties are usually described: (i) Aneurysmal varix, in which the margins of the openings in the vessels are adherent to one another, so that the communication is direct. (ii) Varicose aneurysm, in which the openings in the vessels are connected through the medium of an aneurysmal sac. An unusual form of this which I have not seen described is that in which the sac almost or completely envelops both vessels, so that they lie intrasacculally, though covered over by a similar fibrinous deposit to that found in the rest of the cavity. In the case referred to the bullet had produced "in and out" wounds of both artery and vein, so that four separate vascular openings existed inside the sac.

Signs and Symptoms.

These show a general resemblance to those exhibited by a simple aneurysm, but the following points will usually permit of a differential diagnosis: (i) An intense vibratory thrill, accentuated at systole, and conducted chiefly along the vein, can be felt on palpation. It is much more marked and continuous in character than that which may be felt over an aneurysm. (ii) A very loud murmur is heard on auscultation, also continuous and accentuated at systole. When analysed it appears to consist of two factors: a continuous venous hum, conducted chiefly in a proximal direction, and an arterial systolic murmur, conducted chiefly in a distal direction. (iii) The veins in the neighbourhood usually become distended and varicose; but this is only a gradual development and will not be present in the earlier stages. It may also occur in cases

of simple aneurysm, and so cannot be relied on, *per se*, for a differential diagnosis. Varicose aneurysm usually may be distinguished from the other variety by the presence of a definite swelling or tumour, due to the sac, though the possibility of an independent aneurysm should be borne in mind.

TREATMENT OF ANEURYSM.

Natural cure is not to be expected in any case of traumatic aneurysm, but rather a progressive increase in size. Consequently every case should be submitted to operation unless very special contraindications exist.

The Intrasaccular Route.

The best type of operation to perform will depend upon several factors in the individual case; but in every case (excluding those demanding amputation) where the aneurysm is accessible and temporary haemostasis is possible, the intrasaccular route should be followed and the wound in the vessel dealt with directly. The aneurysm should, in fact, be regarded as a slowly progressing internal haemorrhage, and should be treated accordingly. The advantages of this are so numerous and striking that they deserve special emphasis:

1. It is easy. The aneurysm develops in the line of least resistance, usually towards the surface, following the natural planes of cleavage, so that it is generally more accessible than the vessel itself.

2. It is safe. The sac displaces vessels, nerves, and other important structures aside, so that intrasaccular manipulations avoid the risk of anatomical damage.

3. It affords room. When the sac is opened and emptied the advantages of a clear space are secured, comparable to those obtaining in intra-peritoneal operations.

4. A direct view of the wound in the artery is obtained, and the possibility of conservative treatment determined.

5. The cure of the aneurysm is rendered certain by dealing with the vessel directly at its injured part. Especially is this so where an important branch arises opposite the site of injury, as even extrasaccular ligation on both sides may fail to effect a cure in such a case.

6. It produces a minimum of obstruction in the circulation compatible with certainty of cure.

7. All the contents of the sac are removed. This allows the latter to collapse spontaneously or to be obliterated by suture, thus affording immediate relief of pressure on neighbouring structures; it diminishes the risk of subsequent infection, particularly if a projectile is present in the sac; it facilitates restoration of function in the neighbouring muscles and joints; it diminishes the resistance offered to the collateral circulation and to the venous return, thus minimizing the risk of gangrene; it enables displaced structures to resume their normal positions.

Method of Dealing with the Artery.

The ideal operation is conservative and aims at restoring the circulation through the injured vessel, but it is frequently unnecessary, difficult, or impossible to carry out. Where the opening is small and only involves one side of the artery, restorative endo-aneurysmorrhaphy, as advocated by Matas, should be performed. This is also suitable in cases where the wound is of the longitudinal slit-like variety, and occasionally in the in-and-out type. For large gaping wounds involving most of the circumference it is not practicable, and in these, as in cases of complete division, resection and end-to-end anastomosis are necessary if it be considered expedient to preserve the continuity of the artery.

The alternative to these conservative plastic operations is ligation of the vessel above and below the wound. It is a very simple procedure, and is easily accomplished. The margins of the opening are caught in two or three artery forceps, making slight traction on the artery, and its wall is defined and cleared through the fibrinous lining of the sac for a distance of one-third of an inch on either side of the wound—a light touch of the knife, or even blunt dissection alone, suffices to find an easy plane of separation. The procedure may be correctly described as "trans-saccular ligation," as the parts ligated really lie outside and not inside the sac. If the artery is only incompletely divided, it is perhaps desirable, though not essential, to make the division complete between the ligatures, and any

branch arising from this part of the vessel should also be secured. Where the division has been originally complete both ends must be sought for, usually at a considerable distance from one another or even at opposite poles of the sac, and each ligated in turn. Ligation is indicated in preference to plastic procedures under the following conditions: (1) If the artery is small, unimportant, or difficult of access; (2) if there is infection in the sac; (3) if the extent of the injury is such that suturing or end-to-end anastomosis is impracticable, or very difficult; (4) if the adjacent walls of the artery are injured or diseased, in which cases thrombosis or haemorrhage will probably follow an attempt at suturing; (5) if the patient's condition is such that any prolongation of operation or anaesthesia is undesirable.

Time for Operation.

In the majority of cases the best time to operate is as soon as convenient after the discovery of the aneurysm, provided the surface wounds are *soundly** healed (usually two to four weeks)—that is, as soon as it may be undertaken under ordinary aseptic conditions. By this time collateral circulation will have become established, and the patient will have recovered from initial shock, fatigue, or exhaustion. Earlier operation will be indicated in the presence of signs of infection in the sac, haemorrhage or threatened haemorrhage, rapid increase in the size of the aneurysm, severe persistent pain, and occasionally for increasing signs of pressure on neighbouring structures. The disadvantages of postponing operation to a later period are: Increase in size of the aneurysm; thickening of the sac; increase in amount and duration of pressure on neighbouring structures, particularly nerves; increased difficulty in effecting conservative measures such as end-to-end anastomosis.

Question of Haemostasis.

Haemorrhage from the aneurysm during operation may be controlled either by (1) elastic constriction, (2) the application of clamps to the vessel, or (3) by direct digital pressure applied to the wound in the artery from within the sac.

1. Elastic constriction is the most satisfactory method, but is inapplicable to cases where the aneurysm lies close to the junction of the limb with the body, and to aneurysms of the neck and trunk. I should like to emphasize the fact that constriction should be effected by means of an elastic bandage, and not with the more usual tubular type of rubber tourniquet; the latter produces too narrow and localized a zone of constriction and is much more liable to cause injurious pressure on the tissues. In applying the bandage, the following points should be observed: The limb should be elevated vertically—not bandaged from below upwards—for a short time to allow as much blood as possible to flow out of it; the bandage should be applied well above the aneurysm, so that it may be released by an assistant before the wound is closed without encroaching on the field of operation; endeavour should be made to get the first turn of the bandage just sufficiently tight to control the arterial flow, and subsequent turns should be of similar tension. To do this well some little skill is required on the part of an assistant, but it is really important; if the first few turns of the bandage are applied lightly, and the latter ones with gradually increasing tension, the limb will be in a condition of passive congestion by the time the application is complete.

The advantages of elastic constriction are that it ensures complete haemostasis, it saves time, and when properly applied it is less liable to injure the intima and cause thrombosis of the vessel than is the application of a clamp.

2. Light clamps of Crile's or other pattern may be applied to the artery before the sac is opened. If they are employed, it is desirable to isolate and secure the artery on both sides of the aneurysm, as haemorrhage through the collateral circulation may be quite profuse if only the proximal side is controlled; and even where both are secured bleeding may occur if a branch arises from the intermediate part. Clamps are applicable in many cases where constriction is not; they are readily released and replaced if necessary during the operation, and with a

* About a week should be allowed to elapse after epithelialization is complete before the wounds are considered as "soundly healed." Exfoliating shreds of epidermis should have disappeared, and the skin should be smooth and firm. This condition may be hastened by picric acid dressings.

little care their pressure may be graduated so as not to injure the intima; but time is occupied in exposing the vessel, and the clamps may be accidentally displaced by the operator during subsequent manipulations.

3. Where neither constriction nor clamps are applicable, haemorrhage can certainly be controlled when the aneurysm is opened by the introduction of the left index finger into the sac, and making direct pressure on the wound in the vessel, which can usually be felt distinctly. Even if the vessel has been completely divided and the ends lie some distance apart, they may both be controlled as a rule by introducing the index and middle fingers, and splaying them until each compresses one end. By dissection the vessel can then be exposed, isolated, and secured. It is probably better for the operator to control the bleeding himself than to entrust it to an assistant, even though he is handicapped in the subsequent dissection by having only one hand free.

Technique.

1. At the risk of uttering a surgical platitude it is necessary to emphasize the need for strict asepsis in operative procedures on aneurysms, particularly if conservative measures are to be adopted. If infection occurs where an artery has been sutured, it will almost certainly lead to disaster in the form of secondary haemorrhage, and in the presence of existing infection suturing should not be attempted. The same rule generally holds in dealing with venous injuries, though here it is not so binding; in one obviously septic case the femoral vein was sutured successfully.

Possibly we shall learn in time that greater liberties may be taken in vascular surgery, but at present one does not feel justified in advocating them.

2. As it is impossible to determine by clinical examination what type of wound is present in the artery, all preparations necessary for effecting a plastic procedure should be made before commencing an operation for aneurysm of any of the larger important vessels. The surgeon must be prepared to ligate or suture, according as the operative findings dictate.

3. When the sac has been evacuated, careful and thorough examination should be made to determine the exact nature and extent of the vascular injury. Incomplete recognition of the conditions present may lead the surgeon to waste time in carrying out measures which further investigation proves to be unsuitable.

4. In regard to suturing I have closely followed Carrel's technique, with the details of which most surgeons are familiar. The needles employed are small, round-bodied, either straight or curved, and of the finest pattern. The suture material is fine silk, No. 0 or No. 1, which is sterilized in liquid paraffin at a temperature of 105° C. Carrel advocates the use of vaseline, but I have found liquid paraffin renders the needles and sutures easier to handle, and the results appear to be as good. The sutures are threaded in the needles before sterilization, and all are prepared together. The consensus of opinion now favours silk in preference to catgut, but if vascular suture is attempted in the presence of infection catgut should be employed.

Before suturing, all blood and clot should be carefully washed off the vessel and its surroundings, the edges of the wound should be carefully trimmed with fine sharp scissors if necessary, and the parts should be lightly lubricated with sterile liquid paraffin. Extreme gentleness must be employed in manipulating the wound in the vessel, and the greatest care exercised to avoid injury to the intima, which will probably be followed by thrombosis. Forceps with serrated points must not be used; those with fine spherical ends, as suggested by (I think) Bernheim, are the best, but ordinary forceps may be adapted by stretching some fine rubber tissue over their points.

5. Tension may cause serious difficulty in attempting end-to-end anastomosis in those cases where a portion of the artery has been resected, or where complete division with retraction of the ends has occurred. The artery does not retain its normal extensibility, especially when the aneurysm is of large size and has tracked along the course of the vessel. This appears to be due to "fixation" of its walls by the fibrous lining of the sac, and it may render anastomosis impracticable in an otherwise suitable case.

6. When restorative endo-aneurysmorrhaphy has been performed, the line of sutures may be strengthened by infolding the sac walls over it by a few stitches. After end-to-end anastomosis the junction may be wrapped snugly in a strip of deep fascia taken from the thigh or other convenient neighbourhood.

7. Removal of the sac is not necessary unless special indications exist. (It was performed in one case in my series where the nerves of the brachial plexus were incorporated in it.) In recent cases the walls readily fall together, even without suture, and attempts to dissect them out sacrifice many of the advantages of intrasaccular operation.

8. Drainage may be advantageously employed for twenty-four hours in the case of large aneurysms.

9. When the track of the missile suggests the possibility of direct injury to a nerve, and pressure palsy exists in a degree compatible with this, the nerve should be examined as soon as the aneurysm has been dealt with. If the nerve lies in close relationship to the aneurysm, it may easily be found by incising the sac wall over it from its interior aspect; when the nerve lies some distance away it should be sought for extrasaccularly, or even through an independent incision. The appropriate treatment of the nerve should then be effected.

TREATMENT OF ARTERIO-VEINUS ANEURYSM.

Many cases of aneurysmal varix cause little or no inconvenience to the patient, and may not require operative treatment. On the other hand, varicose aneurysms present the same needs for treatment as do simple aneurysms.

Aneurysmal varix may be treated either by (1) dividing the connexion between the artery and vein and suturing the opening in each, having first applied constriction to the limb or secured both vessels above and below in clamps; or (2) by ligation of the artery above and below the anastomotic opening, and ligation of any intervening branch.

Varicose aneurysm should be dealt with, where possible, by the intrasaccular route. When the sac has been opened and cleared the wounds in the vessels should be carefully examined and dealt with on their merits. In the case of important vessels ligation of both artery and vein together should be avoided if possible; and when the continuity of one appears to depend on the sacrifice of the other the vein should be preserved rather than the artery, except in the case of the internal carotid and internal jugular vessels, where the former is the more important.

THE PHYSIOLOGICAL WORK OF IVAN PETROVICH PAVLOV.

ABSTRACT OF A LECTURE GIVEN AT UNIVERSITY COLLEGE, LONDON.

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ABOUT the beginning of the present year the physiological world received with the greatest regret a report of the death of Professor Pavlov of Petrograd. A few months later a corresponding degree of pleasure was experienced when it was found that Ivan Petrovich Pavlov was still alive and well, and that confusion had been made with a surgeon of the same name.

The frequent spelling of the name as Pawlow, while correct in German, is not so in English. It should be given up, and the spelling here used adopted, as it gives, as nearly as possible, the Russian pronunciation.

There are two large and important regions of physiological work which have been practically created by Pavlov. Although they may appear somewhat widely apart, it will be seen presently how the later work naturally arose from the earlier.

This earlier work was devoted to the function of the digestive glands and the way in which their activity is excited and co-ordinated. Especially it was shown how the process in one part prepares the next following part of the alimentary canal for due treatment of the food when it arrives. The way in which the various glands are set into action and the control of the passage of the food from one section to the next were thoroughly investigated.