

THE PREVENTION OF SHOCK AND HEMORRHAGE IN SURGICAL PRACTICE.*

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INTRODUCTORY.

During the past eleven years I have conducted an experimental laboratory, in which some of the problems suggested in surgical practice have been investigated. On some we failed to throw any light; in some our results were inconclusive; and in others their solution seemed to have been found, or at least useful data obtained. These were published in four monographs, to wit: "*Surgical Shock*," 1897; "*Research into the Surgery of the Respiratory System*," 1899; "*Problems Relating to Surgical Operations*," 1901; "*Blood Pressure in Surgery*," 1903.

On the clinical side during a corresponding period, we accumulated notes on 5,800 major operations in general surgical service, including every variety excepting certain operations on the eye and ear.

The discussion of the various operations is only from the restricted viewpoint of the title of this paper. In the experimental as well as the clinical work my associate, Dr. W. E. Lower, was actively engaged during this time and shares fully with me the responsibility for the results.

In this paper we shall assume that pure surgical shock is mainly due to the effect on the vasomotor centers of the afferent impulses set up by trauma, exposure, etc.; that each such impulse modifies these centers; that a sufficient number of such impulses with sufficient intensity over a given period of time causes the vasomotor centers to lose their excitability; that during the production of this functional impairment and final breakdown the blood pressure becomes irregular, becoming proportionately lower, and when the final stage of complete loss of excitability of the vasomotor center has been reached the pulse in the peripheral arteries can not be palpated and the carotid pressure would probably register not more than 20 mm. mercury. This would represent a picture of complete shock, presenting a very unfavorable prognosis. The symptoms are a close counterfeit of those of hemorrhage, indeed, the state of the circulation is that of a transference of the blood to the venous side of the circulation; that is, it is an intravascular hemorrhage, but because the hemorrhage is intravascular the symptoms should not be unlike those of an extravascular hemorrhage. The afferent impulses may either be of such intensity or of such great numbers, or more usually both, as to cause this functional dissolution.

Among the accessory causes, aside from the afferent impulses mentioned, there may be mentioned certain factors that lower the physiologic resistance, viz.:

(a) Psychical excitation, such as fear, foreboding, etc. This needs only to be mentioned to be admitted, and it has seemed to me to be a more powerful factor than is usually considered.

(b) Hemorrhage. This also is a self-evident factor, and often very difficult to estimate closely.

(c) Cold. The depressing effect of the lowering of the body heat, as noted in exposure to cold on battlefields, in undue exposure in the operating room, and in many physiologic experiments, is well established. In practice I place the patient on a hot-water bed adapted to the operating table.

(d) Acute and chronic infections. In these infections there is a marked physiologic disturbance of many parts of the body, and certainly not the least is the circulatory mechanism.

(e) Anemia, cachexia, collateral diseases, etc.

(f) Age and sex.

Of all these accessory causes of shock we may for our present purpose reduce them to a physiologic basis as follows: The vasomotor centers have a normal definite range of functional capacity. When one or more of these accessory factors enter, this range of definite functional capacity is by so much definitely reduced. This is a plain physiologic law.

In practice one finds one or more of these factors in the vast majority of his patients. That is to say, most of our patients are handicapped in various degrees, from the slight to the grave, even fatal. These handicaps should be our special consideration, and our ability to correctly estimate them on the one hand, and to correctly estimate the vital cost to execute a given technic on the other, constitutes in my opinion the most difficult problem presented to our surgical judgment for decision.

OPERATIONS ON THE HEAD.

Horsley and Spencer long ago demonstrated the dangers of increased intracranial pressure, and Cushing has offered an explanation of the physiologic necessity for the increased general blood pressure under this condition.

In tumors, abscesses and hemorrhages, causing an increased intracranial pressure, the blood supply of the extracranial portion is increased. This was more especially noted in the veins. The blood pressure of the brain under these circumstances is at an irreducible minimum. Therefore, until decompression of the brain has been effected, it would be unsafe to materially lower it either by hemorrhage or anesthesia. After having lost one case of extensive, acute hemorrhage during the second stage of anesthesia, I have in severe cases opened the skull under local anesthesia.

In other instances I have, when necessary, detailed an assistant to give artificial respiration while the bone was rapidly cut away. Alternating heat and cold are perhaps the most powerful respiratory excitants. In two instances respiratory arrest was successfully combated on these lines.

The most severe cases were those of traumatic origin in which opportunity for physiologic compensation was greater. Marked assistance in control of the troublesome venous hemorrhage was obtained by applying the pneumatic rubber suit and placing the patient in the 45-degree upright posture, thereby gaining the advantage of gravity in decreasing the venous pressure in the vessels of the head and maintaining or even increasing the arterial pressure in the same territory. In opening the skull, if by mallet and chisel, it is very important to use the greatest gentleness, as both the clinical and experimental evidence show that the medulla is seriously disturbed by the repeated percussions of the mallet. In opening the skull, in my earlier cases, I am sure that the mallet and chisel provoked some serious circulatory disturbances. Since using only well-beveled, sharp chisels more precisely and a light mallet more gently, I have not detected any circulatory changes.

The supreme importance of reducing to a minimum the exposure and manipulation of the meninges and the brain can only be fully appreciated after noting the circulatory changes and the loss of cortical excitability

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in laboratory experiments. Unless precise arrest of the hemorrhage is made as the operation progresses the operator is quite likely to do unintended damage in sponging.

Since in intracranial operations sudden circulatory disturbances are always imminent, the blood pressure is in all cases continuously noted by a special assistant for that purpose. The patient is inclosed in the pneumatic suit during the early stages of anesthesia, and saline solution and adrenalin are at hand. That is to say, as complete preparation as possible for the control of the blood pressure is made.

CLAMPING THE CAROTIDS.

Since the first case, which was in 1897, I have closed the common or the external carotid artery 51 times with no unfavorable results. The effect on hemorrhage is found to vary greatly. In some the arterial hemorrhage is completely controlled; in others, owing to the greater collateral circulation, but particularly owing to the freer anastomosis, especially through the circle of Willis, a distinct peripheral pulse was noted. That is to say, the blood continued in a pulsating circulation from the opposite unclamped artery through the circle of Willis, causing a reverse current through the peripheral cerebral vessels of the clamped side, re-establishing the circulation through all the branches supposed to be closed off. This reverse circulation in several instances was sufficient to produce a pulsating hemorrhage in the severed terminal arterial branches of the external carotid.

In such cases closure of the external carotid would be more effectual, and in operations in which the factor of hemorrhage is of great moment, as in cases in which the tumor is supplied from both sides, both external carotids have been closed.

The venous hemorrhage, as we have said, is but slightly modified by closure of the carotids. At present the most effective means of lessening the venous hemorrhage is by posture—the head-up posture. In the past this has been the method of choice in all cases in which the danger of cerebral anemia was not present. The pneumatic rubber suit enables us to make free use of this position, as by means of it the blood is not permitted to accumulate in the veins of the body below the diaphragm.

So far as we now know the most favorable condition for controlling the hemorrhage in certain major hemorrhage risks is by closure of one or both common or external carotids according to the location, and the head-up posture with the patient inclosed in a pneumatic rubber suit.

LARYNGEAL AREA.

In such operations as intubations, laryngotomies, laryngeotomies, intralaryngeal operations of all sorts, operators have reported instances of sudden collapse or death.

This is now well understood to be due to reflex inhibition of the heart and of the respiration from mechanical stimulation of the superior laryngeal nerve.

The cardiac collapse may be wholly obviated by previously administering a physiologic dose of atropin, or by applying cocaine on the nerve ending in the laryngeal mucosa, or by injecting its trunk with cocaine. Surgery scarcely claims a more definite law or a more striking phenomenon.

In the eleven total laryngeotomies for carcinoma, in the first two, before the definite cause and prevention

had been worked out in the laboratory, dangerous collapse occurred; in the remaining nine not even a change in respiration or in the heart rate was noted. Because of this dangerous reflex area in the larynx, tracheotomy, not laryngotomy, should be the operation of choice.

THORAX.

In intrathoracic infections with a seriously hampered respiration and a circulation dangerously impaired, one may often with greater safety do a morphin-cocain operation for a mere intercostal opening or resection of a rib, relieving the impending danger, and after the patient's forces are recruited, a more complete operation under surgical anesthesia may be made.

In intrathoracic procedures one must not lose sight of the supreme importance of the respiratory action on the circulation—constituting a great respiratory pump for the circulation, especially for the venous inflow. Even in the normal the circulation is most seriously hampered when both the pleural cavities are opened, thereby eliminating the suction power so necessary to fill the auricles.

In such cases, while by one of the various methods of positive ventilation of the lungs, as by the Fell-O'Dwyer apparatus, in pulmonary collapse oxygen may be freely supplied while the greater danger, that of circulatory collapse, is little if at all obviated. Extensive pressure on the other parts of the body is the most important in throwing back the blood into the thoracic circulation and permitting the heart to refill in the face of the loss of the respiratory pump.

In all intrathoracic procedures one must ever bear in mind the high importance of interfering with the great venous trunks, since their blood pressure is very low, they are surprisingly easily compressed. Such compression would have an immediate disturbing value to the heart's action, equal to a torrential hemorrhage.

ABDOMEN.

In abdominal operations the amount of shock depends in a direct ratio on the trauma and the exposure. This territory bears a rich supply of vasomotor nerves, and the effect of a given operation on the vasomotor center is the sum of the exposure and the intensity and the number of mechanical contacts with the delicately receptive nerves. It follows in practice as truly as in theory that a given operation in the hands of one operator may be manifold more shock-producing, than in the hands of another.

In extensive technical operations, such as the removal of tumors requiring resections of intestines, in certain cases of gastro-enterostomy with entero-enterostomy, in ureteral and in any other time-consuming, exacting technics when no special contraindication exists, morphin-ether anesthesia is used, ether during the abdominal incision, and the exploration and development of the operative field, and morphin alone with slight or no ether accessory during the technic proper, then ether again in closing the abdominal wound.

The region around the diaphragm and the large splanchnic trunks, as in operations for common duct gall stones, operations on the head of the pancreas, etc., is especially shock producing.

The expiratory moan in these upper abdominal operations near the diaphragm may deceive the anesthetizer and mislead him into giving excessive anesthesia. This is entirely analogous to the inspiratory moan while working on the sigmoid or rectum in pelvic operations, or divulsing the sphincter ani. Manipulation in the

peritoneum other than the latter mentioned areas, especially if rough or extensive, may cause an expulsive action, a powerful action tending to force out the bowel by definite straining phenomena. The greater the surgeon's efforts at returning the intestine the greater the mechanical stimulation, and so the greater the expulsive response, which in turn stimulates the operator to greater effort, completing a physiologic vicious circle, which, when once started, continues until either the reflex or the operator is overcome. In acute peritonitis this state is most likely to occur.

In anemias, cachexias and acute infections, a most careful physiologic invoice of the available vitality is made, and a procedure requiring an expenditure falling within such limit is chosen. In illustration, in cases of acute cholecystitis, in deep toxemia, in subjects varying from 36 to 96 years, by a cocain-morphin, or a cocain-morphin-gas anesthesia, a simple opening for drainage was made. After the acute stage had passed, in two cases, under gas or gas and ether, better drainage was provided and in one an impacted stone was removed. All recovered.

The same plan has been repeatedly employed in pelvic and appendiceal abscesses, and in one instance in an abscess in the lesser peritoneal cavity caused by a perforating duodenal ulcer simple drainage under cocain was made and later a radical operation was successfully done. Operative treatment by a process of physiologic progression is not infrequently demanded.

In operations on the pelvic organs we are impressed that this area is somewhat less shock producing than equally extensive dissections above the pelvis.

EXTREMITIES.

The prevention of shock in operations on the extremities has resolved itself into two or three simple propositions, the minimum loss of blood, the minimum manipulation and force, and the "blocking" of the nerve trunks by intraneural injections of cocain or eucain.

In considering the first proposition, surgeons will succeed by individual methods. I have within the past two years adopted the plan of direct dissection, using for the soft parts precisely the same instruments as for a breast amputation. The smaller vessels are secured in passing and a dry field is maintained. The large nerve trunks are exposed as early as possible and "blocked." The larger vessels are ligated and divided as they are reached. Great care is exercised in so dividing the tissue that any further revision is not required. The bone is divided by means of a Gigli saw, obviating the heavy manipulation of retraction of the entire stump when a plain saw is employed.

As an example, in intrascapulo-humeral amputations by first exposing the subclavian artery and vein and the brachial plexus through the same incision each trunk of the plexus is "blocked," the artery and vein are then secured and the skin incision of the part supplied by the cervical nerves is then made. The anesthetic may then be withdrawn, as the major field remaining has been anesthetized by the physiologic "blocking" of the brachial plexus—not only anesthetized but rendered shockless. As no impulses of any kind can pass either upward or downward, there is no more shock in dividing the tissues, even the nerve trunks thus "blocked," than in dividing the sleeve of the patient's coat.

Blood-pressure observations by means of a sphygmomanometer during such operations entirely substantiate this statement. After the effect of the "block" wears

away, however, impulses pass up from the injured nerves just as after amputation by any other method, but the vasomotor centers have been protected against their greatest dangers and can better tide over the crisis.

Since my original publication of the peculiar property of cocain, whereby shock-producing impulses were "blocked" in the large nerve trunks, Matas, Cushing, Gibbon, Lund, Cobb and others have confirmed its value.

SUMMARY.

Every tissue and organ has a more or less individual shock-producing value and must be individually considered. The amount of shock produced by a given trauma varies according to the amount and special quality of nerve supply involved and the number and intensity of the afferent impulses originated by the injury or operation.

Cocain or eucain may wholly "block" these shock-producing impulses. When one or more of the accessory causes of shock are present the highest possible tax is laid on the surgical judgment of the operator. A precise technic offering a minimum of exposure and trauma, grafted on a comprehensive grasp of all the factors entering into the operative consideration, are the ideals for which we must strive.

THE ANTAGONISM OF THE OVARIES AND THE THYROID.—C. Parhon and M. Goldstein (*Archives Generales de Medicine*) review the subject of the relations of the ovarian and thyroid secretions and maintain that a very marked physiologic antagonism exists between them as regards their action on the organism. In support of this opinion they refer to the increase of the thyroid gland as frequently observed at the menopause; the facts that the thyroid seems to favor the normal growth of the osseous system, as shown by its defective development in myxedematous cases, and the contrary action of the ovaries in osteomalacia, as shown by the good effects of castration in that disease; the evident antagonistic action as regards the adipose development, the thyroid secretion being an anti-fat agent, and the normal ovarian functions tending, to a certain degree, toward the growth of adipose tissue. The thyroid favors the growth of hair, which is suppressed to some extent by the influence of the ovaries, as shown by the appearance of hairy growths at the menopause, and their action is also contrary as regards the effects on the circulatory system, the thyroid accelerating the pulse and increasing tension, while the ovarian secretion, they claim, has the opposite effect. They also find similar antagonisms in the regulation of the secretions, in the nutritive metabolism, the output of urates, phosphates, and chlorids, and the elimination of calcium, arsenic, and iodine. The therapy of Grave's disease and chlorosis is also brought into the argument, both being considered by the authors as dependent, at least in many cases, on exaggeration or perversion of the thyroid functions. The question as to whether there exists a similar antagonism between the testicles and the thyroid is suggested as one deserving special study. The authors consider that many facts, such as the effect of castration on the bony growth and the hairy development when performed on young individuals strongly point toward such antagonism.