THE SHOCKLESS OPERATION.

BY P. LOCKHART-MUMMERY, F.R.C.S. ENG.,

SENIOR SURGEON TO ST. MARK'S HOSPITAL, CITY-ROAD, E.C., AND TO THE QUEEN'S HOSPITAL FOR CHILDREN; HONORARY SURGEON TO KING EDWARD VII.'S HOSPITAL FOR OFFICERS; AND SPECIAL CONSULTING SURGEON TO THE CITY OF LONDON AND FULHAM MILITARY HOSPITALS.

SURGERY has at last succeeded in achieving the truly shockless operation, and it has become possible to perform a long and serious operation upon a patient with the certainty that shock will not complicate the procedure. This is a great advance in the history of surgery, one comparable to the achievement of the aseptic operation as the result of Lister's discoveries, although not so important as the latter, since shock is not so dreaded or so common a complication as was sepsis before the discovery of antiseptics. Like the discovery of antiseptics, it is the direct result of the application of principles worked out in the scientific laboratory and subsequently applied in the operating theatre. It is a brilliant result of the application of experimental science to operative surgery—the only true method of progress. Like the discovery of antiseptics, it opens up all sorts of possibilities in the future and removes yet another of the barriers in the way of surgical enterprise. It has now become possible to perform a serious and prolonged operation—such, for instance, as complete excision of the rectum or the removal of a large tumour from the abdominal cavity—without any fear of producing shock, and, in fact, without any disturbance to the patient's general condition, without even increasing the pulse-rate. Further, it is now possible to perform serious operations upon quite elderly people and upon what the insurance companies call "bad risks" with a very considerable degree of confidence.

The ideal method of repairing the human body, were it possible to treat it as a machine, would be to remove the damaged part, such as an eye, a foot, or a hand, repair it under the best and most advantageous conditions, and then reattach it to the body to which it belonged, in the same way as we should do in the case of a motor-car or any other man-made machine. By such a process, repairing the part would not cause any injury or inconvenience to the human body to which it belonged beyond that incidental to the body's being deprived temporarily of the part to be repaired. Unfortunately, this method can never be possible in dealing with the human body, but the shockless operation is the same in principle. The damaged part is isolated from the rest of the human body by local and regional anaesthesia while it is being repaired, and at the same time the patient is kept in a condition of artificial sleep, so that the body, through the brain and special senses, will not be damaged from the psychological influences incidental to the operation which is necessary to repair the damaged part.

In a shockless operation the area of the operation is shut off from the sensorium by means of local anaesthesia. This anaesthesia must be so complete that if the patient were conscious no pain would be felt. Every sensitive tissue is injected with a solution of 1 in 500 novocaine before being divided, or what is better, if it can be done, the main sensory nerve-trunks are injected so as similarly to shut off the desired area.

The operation itself is performed in such a manner as to cause the least possible trauma—that is to say, with light handling and sharp cutting, tearing and blunt dissection being inadmissible. Meanwhile the patient is kept in a condition of artificial sleep by a suitable combination of anaesthetics. First of all, a preliminary injection of morphia (or morphine and scopolamine) is given, the dose of which varies according to the type of patient, and is roughly from 1/8 to 1/3 gr. This should be given an hour before operation, so that the full effects are felt at the time of induction of anaesthesia. Secondly, a general anaesthetic is administered in order to keep the patient quite unconscious. The object of the general anaesthetic, however, is only to produce unconsciousness, and not relaxation or even anaesthesia. The method of combining several forms of anaesthesia was first suggested by Dr. G. W. Crile, who called it "anoci-association"¹ anaesthesia because its object was to cut off from the patient's central nervous system all "noci" (or harmful) impressions. This name, while it may have advantages

from a purely scientific point of view, is rather clumsy and has little to recommend it. Nor does there seem any necessity to label this method with a name. It is simply an improved technique by which the shockless operation can be attained.

The best general anaesthetic, in my opinion, is gas and oxygen, ether or chloroform being added if necessary, but only used in very small quantities and for a few minutes at a time, as, for instance to help during the induction of anaesthesia in a very muscular or alcoholic subject, or to tide over a period during which it is necessary to handle some part of the abdominal contents which cannot be properly isolated by local anaesthesia. The form of gas and oxygen anaesthesia which appears to me to give the best results is by re-breathing into a large bag, oxygen and fresh N₂O gas being added as occasion demands. This is the method used by Mr. J. H. Chaldecott, who has given the anaesthetic for most of my cases, and the one with which I have certainly obtained the best results.² The total amount of gas used is very small; in one case only three-quarters of a 100-gallon cylinder of nitrous-oxide gas was used in 1 hour and 50 minutes. The patient is kept under the anaesthetic until he is back in bed, and in most cases is conscious in three or four minutes after the mask is removed.

The important point about the general anaesthetic is that instead of the gas or drug being used, as hitherto, to produce anaesthesia, it is only given in sufficient quantity to produce unconsciousness, sometimes hardly that. The ideal condition is the one in which the patient will react to stimuli, will answer if spoken to loudly, or move if hurt. I always ask the anaesthetist to let me know if he sees any sign of stimulation, as this is evidence that the local and regional anaesthesia is not efficient.

Many factors have to be considered before successful results can be obtained. Not the least important is the technique of the surgeon. Those surgeons who tear and separate the tissues with their fingers, and who perform most of the operation by what is called "blunt dissection" can never hope to attain to the really shockless operation. There are some surgeons whose only use for a knife is to cut through the skin, and who perform most of the operation with their hands assisted by blunt instruments. They point, often with pride, to the speed with which they can work and to the small amount of bleeding—advantages, it is true, but obtained at a heavy cost in other respects.

The shockless method of operating involves a somewhat more elaborate technique, and, at first at any rate, takes longer than if a general anaesthetic alone is used. With increased experience in the method the only extra time added on to the operation is that taken up in injecting the local anaesthetic, and should not amount to more than five or ten minutes in a long operation. On the other hand, the shockless method of performing an operation makes the length of time occupied in performing an operation of much less importance, since the amount of general anaesthetic used is relatively much less and shock cannot occur. So far I have seen no harmful results from the injection of novocaine, even though I have often in a big operation used as much as 4 or 5 ounces of a 1-500 solution. No difference can be seen in the tissues at the end of the operation, and the healing of the wound is in no way altered or delayed. The only contra-indications to the method that there would seem to be are in some septic cases where there might be danger of spreading the infection by the injections, and in some cases of cancer where there might be a similar danger of spreading cancer cells. The latter should seldom occur, as no operation for the removal of cancer should ever involve cutting through tissues infected with cancer cells. In any case these objections do not apply if the nerve-trunks are anaesthetised by regional anaesthesia.

The use of urea quinine hydrochloride has certain disadvantages. It may cause an oedema lasting several days, though I believe this is due to the use of too large and too concentrated solutions. Personally, I do not like to inject it into the immediate neighbourhood of the wound.

The advantages of the shockless method of operating are much lighter anaesthesia with, consequently, less probability of subsequent sickness, almost complete absence of post-operative pain, absence of rigidity, and, most important of all, complete absence of shock even after severe and prolonged operations.

¹ Crile and Lower: Anoci-Association, 1914. Crile: Surgical Shock, 1897.

² J. H. Chaldecott and C. W. G. Bryan: The Value of Anoci-Association, THE LANCET, Sept. 6th, 1913, p. 721.

The great advantages are more particularly seen in serious operations upon elderly or feeble subjects, and where an operation has to be performed upon an individual who is especially liable to have post-operative vomiting. In any case, the advantages from the patient's point of view are not inconsiderable, and seem to me to be well worth the additional trouble involved in the operative technique. The absence of post-operative vomiting is a very great advantage, as it is impossible to estimate the amount of damage which must often result in abdominal cases from the straining which necessarily accompanies vomiting. Surgeons have become so used to post-anæsthetic vomiting as a necessary evil after operations that they do not worry about it; but they will all agree that it is a most undesirable complication after any abdominal operation. It tends to start hæmorrhage afresh, it makes the stitches cut into the skin, it causes severe pain in the wound, it prevents sleep, it stops digestion, and, in fact, it would be hard to find any other complication which could cause as much damage to the surgeon's handiwork as vomiting. Complete rest for the abdominal cavity is what every surgeon desires for some hours after he has performed a laparotomy, but this is exactly the opposite of what occurs if there is vomiting. Allowing the patient to walk about immediately after an abdominal section would be considered little less than criminal, and yet it could not possibly do as much damage as vomiting.

The following cases are quoted as showing the advantages of this method in special cases.

CASE 1.—A fragile woman, aged 71, was sent to me by her medical attendant on account of a large tumour in the left side of the abdomen which was causing her acute pain. This pain was not relieved effectually by drugs, and she was very anxious to have something done. The tumour, which proved to be a chronic tubercular kidney, occupied the whole of the left side of the abdomen, and after removal was found to weigh nearly 7 lb. The operation was performed by the shockless method, 1/8 gr. of morphia being given before the operation and continuous gas and oxygen used with local and regional anæsthesia. The operation of removing the kidney occupied 50 minutes, for as it was very much fixed by adhesions its removal was quite a difficult matter. Three minutes after cessation of the anæsthetic the patient was quite conscious. She was not sick at all, she had no after-pain, and she was able to have her ordinary tea at 4.30 in the afternoon. Her pulse-rate never altered at all as the result of the operation, and she appeared to suffer no inconvenience in consequence of the operation.

CASE 2.—I first saw the patient, a woman aged 75, with her family physician on account of a large carcinomatous growth situated at the junction of the rectum and sigmoid. She was exceedingly anxious to have this removed if there was any chance of a successful result. A preliminary colotomy was performed, and ten days later the operation was carried out in the same way as in the previous case. The entire rectum, anus, and surrounding skin were removed, together with some inches of the sigmoid flexure. The peritoneal cavity was extensively opened up, and 8 inches of bowel were removed. The operation took 1 hour 50 minutes. The patient was conscious in less than five minutes after being back in bed, and her pulse-rate was only 84. She never caused the slightest anxiety or showed any signs of distress as the result of the operation. She was not sick and did not lose her appetite. She was able to return home in less than a month after the operation.

CASE 3.—A hospital patient, aged 62, was admitted to St. Mark's Hospital with a large growth at the upper end of the rectum, involving the posterior vaginal wall. She was a very fat and flabby subject, and appeared to be a very unsuitable individual for a serious operation. She was operated upon by the same method, the operation taking nearly two hours. She left the operating table with a pulse of 86, was not sick, showed no signs of shock, and caused no anxiety. She was out of bed three weeks after the operation.

CASE 4.—An army officer, aged 52, was sent back to England from a military hospital suffering from carcinoma of the upper part of the rectum, and having just recovered from a serious attack of dysentery. He appeared to be, in the ordinary way, rather a bad risk for an operation. The operation was performed by the shockless method and took about two hours. The pulse-rate was not at all increased, the patient was conscious a few minutes after the operation, and two hours later was propped up in bed reading the newspaper. It was difficult, in fact, to believe that he had undergone a serious operation.

CASE 5.—The patient, a woman aged 73, was operated upon for chronic intestinal obstruction. The operation took 1 hour 15 minutes, and was performed under gas and novocaine anæsthesia. A thorough search of the abdominal cavity was necessary to find the obstruction, which proved

to be a band of adhesions (there was considerable distension of all the intestines). The uterus and bladder were stitched up to the anterior abdominal wall to rectify a prolapse. The pulse-rate never went over 84. The patient was not sick, and she recovered without causing a moment's anxiety.

It is my belief that these patients could not have been operated upon successfully in the ordinary way, or at any rate that the risk would have been so great that one would have hesitated to attempt the operation. By the shockless method, however, they were not only able to get through the operation satisfactorily, but they never caused the slightest anxiety, and there was nothing in their general condition a few hours after the operation to indicate that they had undergone an operation. All of them were not only hungry but able to digest their food within 24 hours of the operation.

It must not be supposed that the shockless operation is just a new method which can easily be adopted. It is not so much a method as a series of principles by the careful coördination and coöperation of which the desired result can alone be obtained. The surgeon who wishes to achieve success with the shockless operation must have much patience and take a great deal of trouble to acquire the necessary technique; and he must have an anæsthetist, an assistant, and nurses who understand and are capable of applying the necessary principles.

The credit for the discovery of the shockless operation is due almost entirely to Dr. Crile. Although for more than 12 years I have been working in the same experimental and clinical field I have not had his opportunities, as in this country every difficulty is placed in the way of experimental work instead of its being encouraged as it is in America. In my Hunterian lecture on the Physiology and Treatment of Surgical Shock,³ published in 1905, I predicted the coming of the truly shockless operation, and Dr. Crile's investigations have now rendered this an actual fact. From 1905 to about 1908 Mr. W. L. Symes and I carried out a number of experiments⁴ at the University of London, the object of which was to ascertain what were the important factors in abdominal operations tending to produce shock, and how they might best be combated or avoided. Briefly, we proved that there was a great difference in the shock-producing effects of different kinds of wounds. Whereas wounds made with sharp instruments and accompanied by gentle manipulation, even if extensive, produced very little shock, the exact reverse was found to be the case with wounds produced by blunt dissection and accompanied by rough handling of the tissues. Further, we found that preliminary injection of morphia tended markedly to prevent shock. Our conclusions were never published. Fortunately, similar but much better and more exhaustive experiments on the same lines have been performed by Dr. Crile in America, and his results have been published. It is satisfactory to note that his conclusions are the same as those at which we have arrived, although he has carried his proofs much further than we were able to do. Another result of our experiments was the discovery of the value of extract of the infundibular portion of the pituitary gland in combating shock. Since then this extract has been to some extent standardised, and is one of the most valuable drugs we possess for its effect upon the unstriated muscle-fibre.

My chief excuse for this paper is that the shockless operation does not seem to have received the attention from English surgeons that it deserves. Very few surgeons in this country appear to be using the method at present. Sir Berkeley Moynihan⁵ advocates it as a routine method, but still apparently uses ether as the main general anæsthetic. Colonel H. M. W. Gray has also adopted this method, and has advocated it in a recent paper.⁶ The present war has interfered very seriously with all advances in surgery which have not a direct bearing upon the treatment of the wounded, and a somewhat elaborate technique, such as is here involved, is doubtless very difficult of application on the field. This is to be regretted, as the condition of seriously wounded men requiring immediate operation is one particularly predisposing to shock.

Hyde Park-place, W.

³ Lockhart-Mummery: *The Physiology and Treatment of Surgical Shock and Collapse*, THE LANCET, vol. i., 1905, pp. 696, 776, 846.

⁴ Lockhart-Mummery and Symes: *Some Points in the Experimental Production and Control of the Vascular Atony of Surgical Shock*, Brit. Med. Jour., Sept. 19th, 1908.

⁵ Moynihan: *Abdominal Operations*, 1914.

⁶ Gray: *General Treatment of Infected Gunshot Wounds*, Brit. Med. Jour., Jan. 1st, 1916.

INTESTINAL TOXINS AND THE CIRCULATION.

By D. T. BARRY, F.R.C.S. ENG., M.D.R.U.I.,
PROFESSOR OF PHYSIOLOGY, QUEEN'S COLLEGE, CORK.

FOLLOWING up the investigation of the action of excretory toxins on the neuro-muscular mechanism of the heart, I have tried to ascertain approximately the level at which the alimentary toxin begins to be formed.

As in the previous experiments, the toad's heart was perfused through the inferior vena cava, using the intestinal contents, which were mixed with Ringer's solution in a mortar, and the solution rapidly filtered with the aid of a water-pump. Too much filtration with long exposure to the air diminishes rapidly the toxicity of the extract. Dogs and cats which were used for class demonstrations provided the material. An attempt was made to remove the toxin by dialysis in a collodion dialyser as recommended by Bigelow,¹ but the dialysate was almost inactive. Most of the cats received in this laboratory suffer from nematode worms, and in these cases, if we get over the difficulty of finding a sufficient quantity of material—the small intestine is almost empty—the toxic effect is slight. The worms, *plus* the contents got by gentle scraping of the gut in these cases, were pounded in a mortar with Ringer's solution.

The effects on the blood pressure and heart beat of intravenous injection of the intestinal contents of the animals themselves were also investigated. A glass tube was tied into the external jugular vein and about 5 c.c. of the extract allowed to run into the circulation, after previous warming to a temperature of 37° C. Prolonged warming, even at low temperatures, diminishes the toxic action.

It is well known that the mucous membrane of the intestine contains depressor substances, extracts made in the preparation of secretin, for instance, showing their presence. Light superficial scraping, however, does not extract them. In the present experiments where the contents were abundant no scraping was necessary, but it was employed very lightly when the contents were sparsely found. Injections of light scrapings have been practised in the investigation of hormones affecting the secretion of intestinal juice, but without marked blood-pressure changes.

Method.

The method employed was to subdivide the small intestine into upper, middle, and lower thirds, of which the contents were mixed with Ringer's solution, 5 gm. in 50 c.c., filtered and neutralised. In the text these extracts are numbered 1, 2, and 3 respectively from above down. The contents of the cæcum were also used and this mixture is numbered 4. In each case the animal is specified, "2 cat," for instance, meaning the contents of the middle third of the cat's intestine.

All the extracts were acid to phenolphthalein and were made neutral by the addition of standard alkali and certain indicators. With these indicators it was estimated, according to the table given by Bayliss,² that the H concentration was between 1×10^{-7} and 1×10^{-8} in all extracts used. With phenolphthalein the hydrogen ion concentration is 1×10^{-9} when the colourless solution just changes to pink. A definite pink colour was allowed to develop in the extracts with this indicator by dropping in the alkali, and this was then just dispersed by careful addition of further extract. The solution then gives a faint orange tint with neutral red, and pure red with Congo red.

The glass cannula used in the former experiments was discarded in the present series for a junctional piece consisting of vulcanite. This is of crucial form, the bore being one millimetre throughout. It was made for me by Messrs. Hawksley and Sons. One limb of the junctional piece is attached by rubber tubing to a small glass cannula of which the bore does not exceed one millimetre. The other three limbs are connected with perfusion bottles. This arrangement facilitates washing out and changing of the fluid in one or more bottles without removing the cannula from the vein. The dead space in the combination is almost negligible. The rate of flow was regulated in the manner

described in a previous paper.³ One perfusion bottle always contains Ringer's solution and the other two the material to be examined for toxic effects. The aortæ were cut across to give free exit to the fluid. All the records read from left to right. Tracings of the auricle (upper) and ventricle (lower) are given. Most of the extracts show a toxic action on the muscle or nerves, an effect which is slight in the upper portions of the gut and increases as we proceed downwards. Speaking generally, the varying effects can be interpreted in terms of degree or intensity of action. The most marked action is on the ventricle or on the auriculo-ventricular bundle.

A simple and uniform loss of power in the contractions without change of rhythm (Fig. 1) is sometimes seen, but it

FIG. 1.

Record of auricular (A) and ventricular (V) contractions of a toad's heart perfused with extract (1) of cat's intestine for the period between the crosses. At the thick line the drum was stopped and Ringer's solution perfused. The record reads from left to right.

is not usual, irregularity of the ventricular beat being one of the most common and prominent features. In the first tracing, 1 (cat), it will be seen that the ventricle fades off in force some time before the auricle is affected and the rhythm is maintained. At the thick line the drum was stopped for a few minutes, during which perfusion with Ringer's solution was carried out. This fully restored the beat, but the rate on recovery was somewhat slower than previously. The accelerator fibres to the heart undergo depression in these cases, as is shown by a stimulus applied to the crescent, which before perfusion gives initial acceleration, but subsequently to perfusion gives none. There is no increased tone, rather the reverse, and the action has to be described as an enfeebling one, especially on the ventricle, with no appearance of block. Further perfusion with the same extract gave similar results. A general consistency of action has been noticed for a particular extract, allowing for the fact that the toxicity tends to disappear with time.

A more common result from No. 1 toxin is a change of rhythm. (Fig. 2.) In the first part of this tracing, 1 (dog),

FIG. 2.

Toad's heart perfused with extract (1) of dog's intestine. Note the 2:1 rhythm. At the point marked with a cross the drum was stopped and extract 2 (dog) substituted. Complete heart-block follows.

only every other beat of the auricles succeeded in sending over an effective stimulus to the ventricles—that is, a 2 to 1 rhythm. At the point marked with a cross the drum was stopped for about half a minute, during which perfusion

¹ Bigelow and Gemberling, Jour. Amer. Chem. Soc., 1907, p. 1576.

² Principles of General Physiology, 1915, p. 189.

³ THE LANCET, May 22nd, 1915, p. 1070.