

PARKES, (G.T.)

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A REVIEW OF SOME FACTS CONNECTED WITH  
GUNSHOT WOUNDS OF THE ABDOMEN,  
AND PRACTICAL DEDUCTIONS  
THEREFROM.<sup>1</sup>

By CHARLES T. PARKES, M. D.,

OF CHICAGO.

PROFESSOR OF ANATOMY IN RUSH MEDICAL COLLEGE.

THE object of this contribution to the subject of gunshot wounds of the abdomen is to pass in review such facts as are at our disposal in its consideration, to make such deductions from these as their limited number will afford, and to offer some suggestions based on personal experience.

Probably no question submitted to the consideration of surgeons has ever arrested the attention of the profession more promptly than the general question of surgical interference in penetrating gunshot wounds of the abdominal cavity, and it is at once remarkable, and to the honor of the profession, that the obvious deductions have been as promptly applied.

Up to 1885 the whole number of recorded operations for gunshot wounds of the abdomen that I have been able to find is six; by this is meant cases in which the surgeon has deliberately sought out the wounded intestines, and repaired the damage inflicted, in accordance with surgical principles.

Surely, a small number in view of the wars which have gone by, contributing and bringing under the surgeon's care, great numbers of these injuries under consideration, and the many individuals shot through the abdomen in brawls of civil life, also placed under medical supervision.

Up to 1885 the profession had not looked the real question square in the face; surgeons held uncertain opinions, with the

<sup>1</sup>Read before the Surgical Section of the Ninth International Congress, September 5, 1887.

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large majority opposed to any interference whatever, and, as might be expected under such complicating conditions, the results were not brilliant. Operations previous to three years ago were the exception. The magnitude and importance of the subject seemed not to be realized.

Now, I would venture the assertion that there are few modern surgeons who, confronted with a bullet wound of the abdominal walls and not able to convince themselves that the ball had not effected a penetration, but would explore the cavity.

When in the winter of 1884 I reflected on the necessity of systematically and experimentally studying this subject, I did not anticipate that in so short a time such radical change would take place in the method of treating such cases, which, previously had been relegated to cure by opium, rest and hopes in Providence.

The results of my observations were published in the *Journal of the American Medical Association*, in 1885; they were the observations and outgrowing deductions from a series of experiments systematically carried out during the previous winter for the purpose of throwing light upon the pathology and treatment of these injuries, and of recording the clinical facts attending shot wounds of these organs.

Since the publication of my address to the American Medical Association in 1885, thirty-six cases of operative interference in gunshot wounds of the abdomen have been recorded, with nine recoveries following opening the abdomen, suturing the wounded intestines and treating other complicating injuries.

Sir William MacCormac in the Annual Oration delivered by him May 2, 1887, before the Medical Society of London, has collected from all sources thirty cases. To these must be added one case reported by Prof. McGraw, of Detroit, of double perforation of the ascending colon, exposed by enlarging the surface wound, and suturing the intestinal perforations; recovery following. Another, by Dr. J. B. Murphy, of Chicago, of shot wound of the liver, in which the abdomen was opened, blood clots removed, and the wounds sutured; recovery following. Also a death, reported by Dr. J. B. Mur-

phy, from post-peritoneal hemorrhage; post-mortem showing the intestinal wounds to have been safely sutured. One other case of recovery is reported by Dr. J. J. Skelly, of Potomac, Ill., and two fatal cases coming under my own care, to which further reference will be made in this paper; in all thirty-six cases, with nine recoveries.

A reference to the extended reports of these cases, or, to the tables of Sir William MacCormac, shows plainly that there has been no selection of favorable conditions; that the operations have been done under a great diversity of surroundings, without special assistants, and in many cases with injuries the fatality of which it seemed impossible to overcome.

These results furnish the greatest encouragement for further trials in saving the lives of persons so certainly condemned to death, unless relieved by operation, when suffering from the wounds under consideration.

Every case, whether of recovery or death, following operation should be published in full, so that our experience may be increased, the nature and character of these wounds better understood, and definite rules of procedure elucidated. We might in this way be able to set aside those cases, which from the special character of the wounds will necessarily prove fatal. With our present limited knowledge of reliable symptoms, all is uncertain with an unopened abdomen. Gradually we may be able to positively recognize these cases which possess "a faint hope of relief" to be followed by a good percentage of recoveries after operation. Where to draw the line, and what to do, when operation is decided upon, and how best to carry out the necessary manipulations, are the questions which the future must settle.

Judging from the valuable papers of Drs. Bull, Dennis and Bryant of New York City, Dr. Tremaine of Buffalo, Dr. Nancrede of Philadelphia, Dr. Senn of Milwaukee, Dr. Marcy of Boston, Genl. Hamilton of Washington, Sir William MacCormac and others, and from the expression of opinion, published as coming from the surgeons present at the last meeting of the American Surgical Association, it is certainly just to claim, that the belief that surgical interference in proper cases is the accepted course to pursue is rapidly being adopted by the profession at large.

To me this is a great victory gained. The method of procedure has been tried; and notwithstanding the crudest of data to build upon—the deficiencies in practical experience in man; with propositions already made not thoroughly tested, or perhaps only superficially studied, with the dimmest of light for a guide, the results have been remarkably good.

What interferences are justifiable from an external gunshot wound of the abdominal walls?

A single wound of the abdominal walls, in so far as it affords any inference at all, from its being single, furnishes a hope that no penetration of the peritoneal cavity has taken place, but it is merely a hope.

The resistance of the walls and viscera, though considerable in every case, varies greatly. Consequently, a bullet, although not having momentum enough to make an exit, may have force enough to do much damage among the viscera. Or its momentum may be so slight, and its direction so oblique, as to cause it to remain between the planes of the abdominal walls. Even the existence of an entrance and exit wound widely separated is not always a proof of injury to the viscera. Observations have shown, both on man and the lower animals, that a bullet may enter the abdominal walls at one point and reappear at another, at a considerable distance from the first, and yet not enter the abdominal cavity. If penetration be present with only a wound of entrance, it suggests that the firearm used might have possessed moderate penetrating force, that the velocity of the bullet may not have been extreme, and that the damage done by it is very likely amenable to treatment, with fair prospects of relief.

If there exists a continuous track of tenderness, especially if accompanied with slight redness, from the wound of entrance for some distance over the abdominal surface, it is fair to infer that the missile has wormed itself between the layers of the abdominal walls, and that penetration does not exist. This was plainly shown in a case seen in 1886, and reported by myself in a paper read in New York that year.

The peculiar appearance presented by the edges of the wound, and its size, when carefully studied, will furnish pretty reliable information of the size of the bullet, and its direction

of impact, both items of considerable importance in estimating the possible damage.

Bullets from firearms of large calibre are the most destructive to the opposing tissues, and have the maximum penetrating force. A large bullet hole argues a large bullet, certainty of penetration, and large destruction of tissues and organs.

Powder marks on the clothing or body prove a close body shot, and hence greater probability of complete penetration of the abdominal cavity, with wounds to the viscera; and this is true, no matter what may be the calibre of the firearm used.

If the edges of the skin perforation are equally stained throughout and clean cut, the fact suggests that the bullet struck perpendicularly to the surface upon which the wound is found. Again, if these edges are unequally stained, if unequally ragged, or if the surrounding surface shows a stain, or abrasion, or discoloration leading to some portion of the edge of the perforation, all these facts suggest valuable information as to the probable course of the missile in its transit through the abdomen, and the conclusion is justifiable that the impact was not perpendicular to the surface, and, of course, in proportion as the course of impact departs from the perpendicular, the greater is the probability that penetration of the cavity has not occurred.

Naturally, one of the most important items of estimation is to determine the probable course of the injuring body. To this end information as definite as possible must be obtained as to the direction in which the shot came, and the distance from which it was fired; both facts having great bearing on the organs wounded, and the damage done them. It is no easy matter even with very complete data to guide one, to feel certain as to the direction of the missile inside the cavity, when there is only one wound. A great many cases will furnish no corroborative information; the surgeon will be compelled to depend upon the signs belonging to the wound itself.

If in doubt as to penetration, the wound should be enlarged by an incision directly through the skin perforation in some chosen direction. By carefully following the track of discoloration left in the tissues by the bullet, not only the fact of penetration or non-penetration will be positively determined,

but its directness or obliquity through the abdominal walls, will furnish positive information as to the course of transit of the entering body. With the usual precautions this incision will not increase the patient's danger, even if central section becomes necessary; it throws valuable light upon subsequent requirements, makes clear the fact of penetration, or non-penetration, and, in some situations, may enable the operator to repair all the damage done.

The presence of a wound of entrance and exit, produced by the firearms and missiles of the present day, especially if the shot is delivered in close proximity to the body, with scarcely an exception possible, indicates injury to all the fixed organs lying in the estimated line drawn between the two external wounds made by the missile. Moreover, it is highly probable that the small intestines are also damaged, although these latter wounds may be found some distance away from the line of the ball, their changed position being dependent upon the extreme mobility of the viscera at the time of the receipt of the wound, and from the movements of the body subsequent to the passage of the bullet or other causes.

The great majority of double wounds tell positively of complete and direct perforation and damage, more or less severe, to every organ in their path, there seems scarcely any probability of deviation from their course, caused by the resistance of the soft tissues of the body.

Whether wounds in organs (as contended by Prof. McGraw), found some distance away from the line of transit of a bullet, are to be explained by the elasticity and mobility of the tissues, their constant change of form by inherent contraction, enabling them to get in or out of the way, or by subsequent change induced by weight of the bullet or movements of the body; or, as contended by myself, are sometimes dependent upon an erratic course of the latter, from deviations in its line of flight, caused by deflections therefrom, through impingement on tissues of different powers of resistance or elasticity, is a matter that must be settled by an appeal to physical laws through experimentation; it will never be settled by assertions or assumptions. I am fully convinced that the time does come in the "life" of a flying bullet when its velocity and power of

penetration bear such a relation to the power of resistance of the different tissues in the abdominal walls and contents, that the softest of these, touched in a certain way, will deflect its course. In no other way than through this supposition have I been able to explain the character and kind of damage I have seen done by a bullet in its transit through the body.

My conclusions and deductions, on the course of a bullet, are based mainly upon the results of experimentation, during which the animal was profoundly anesthetized, and consequently muscular contraction and activity abolished. If the ball deviated at all from a straight line, there was nothing else to cause the deviations but the soft tissues in its track.

The situation of the wounds will, of course, call attention to the likelihood of damage inflicted upon the organs, in the probable course of the bullet. The severity of the injury and gravity of prognosis is surely greatly enhanced if the movable viscera are wounded. It is much less if only fixed organs are hit. In both the absolutely necessary manipulations by the surgeon, required for the repair thereof, will be suggested, and due preparation to meet all indications can be provided for. There is no opportunity to hunt up necessary appliances after the operation is begun.

An antero-posterior shot below the level of the umbilicus and well toward the lateral surfaces of the body, will be very likely to miss the small intestines entirely and expend its damage on the large bowel, as in Prof. McGraw's case. The same kind of wound high on the lateral surfaces may pass into or through the liver, without injuring the intestines, or the spleen alone if the entrance is on the left side.

If the wound is so situated that the bullet enters the abdomen through the diaphragm, adding injury of abdominal viscera to that of the contents of the chest, the surgeon's help will probably be of little use.

A wound of entrance and exit, or an entrance wound alone showing perforation of the ball from side to side through the cavity, means the worst of injuries, and suggests the need of the greatest care in staying of hemorrhage, repair of intestines and toilet of the contents.

Antero-posterior perforation, if complete, can only fail to

wound the small intestines when situated well on the outskirts of the surface of the abdomen ; seemingly, there can be no exception to this proposition, save in those extremely rare instances, in which the perforating body traverses the cavity without injuring the contents.

Penetration through the posterior walls of the cavity, if complete, with likelihood of laceration of important fixed organs, argues an injury of the most severe character, one in which the surgeon's art will be of no avail in the majority of instances. The exceptions, in which the severity will not prove unsurmountable, will be transit through the space between the lower end of the kidney and the crest of the ilium, and in wounds occupying the outskirts of the entire posterior surface. If the penetration be incomplete, as can, in the majority of instances, be determined by enlarging the bullet wound, the injuries are by no means necessarily fatal, and do not require any other surgical interference than enlargement of the wound and proper dressing. Many instances are recorded of recovery from posterior penetration of the large and fixed viscera of the abdomen, without any surgical operation whatever.

What collateral evidence influences the formation of a diagnosis ?

The peculiarities of the individual injured constitute so important an element in the development of collateral manifestations, that all such testimony should be subjected to the most rigorous search, in fact much value cannot be attached to subjective manifestations. It is not necessary to state to you that one person may be prostrated and literally frightened to death by the sound of a firearm, or the "swish" of a bullet, while another will continue his course or perform his usual duties after he has been injured, and can only with difficulty be persuaded that he has been shot. Between these two extremes all gradations present themselves.

There are other phenomena, independent of personal peculiarities, which contribute to the formation of the surgeon's opinion. Among these may be mentioned: tympanitic resonance, unusual dulness on percussion, the presence of fæcal matter, or any of the normal secretions or contents of the different viscera in any of the external wounds, blood in the



stools or urine, or egesta from the stomach, paralysis of any kind, persistent nausea and vomiting, and the general condition designated shock.

Allow me to briefly refer to the probable significance of these symptoms when present.

Unusual and rapidly forming tympanites would suggest the escape of the intestinal gases into the peritoneal cavity through a perforation, and, if found in a region of normal dulness, as in the liver region, it is considered good corroborative testimony in favor of intestinal rupture, by some authorities.

Circumscribed dulness on percussion, with localized bulging in the abdomen in the neighborhood of the wounds, or in the most dependent region of the cavity, argues the possible presence of blood accumulation from wound of a large vessel, and consequent penetration of the abdomen.

The rare but possible phenomenon of fecal matter appearing in the external wounds renders the demonstration of perforation of the alimentary canal absolute. That such extrusion does occur as an early symptom after wounds made by large bullets finds illustration in the case to be reported by myself in this paper.

The presence of blood in the urine, in connection with the situation of the external opening, demonstrates wound of the kidney, ureter or bladder; the two former adding greatly to the gravity of the prognosis, and certainly in so far as its presence influences opinion at all, such condition would favor the necessity for operative procedure.

Paralysis of any part of the body, below the level of wounds in the abdomen, necessarily complicates matters very much, rendering it very probable that the ball has not only injured the viscera in its course, but has also done irreparable damage to the spinal cord or important nerves.

"Shock" cannot be relied on as a positive indication of the presence or absence of perforation of the viscera. Cases with many perforations have presented no evidence of shock whatever. Its presence is rather an indication of some special nervous condition of the patient, of some injury to nervous structure, or, perhaps, more often than any other condition, it indicates the laceration of some large blood vessel with free bleed-

ing, the last a condition of itself requiring abdominal section for its relief quite as surely as the rupture of the sac of tubal pregnancy, and proving quite as fatal if the operation is not done.

It is to me a source of disappointment to be compelled to put the presence of "shock" among the doubtful signs of perforation, for I was at one time fully convinced that its presence surely meant bowel wound, and I am still of the belief that when present, the probability of such injury is very great.

Absence of pulsation in either of the femoral arteries will call attention to injury of the iliac vessels, and as well, when present, gives a second point with which to estimate the course of the bullet.

In three cases of penetrating wounds seen by me, all had persistent nausea and vomiting present. Other reported cases have shown similar symptoms. It is also a common symptom with ruptured intestine from other causes: hence I deem it proper to claim that its import as a symptom be borne in mind.

What symptoms make it probable that the issue in any case will be fatal, whether operated upon or not?

It seems quite proper to say that the majority of cases of through and through perforations of the abdominal cavity, with injury to both fixed and movable viscera and blood vessels, will prove fatal in spite of the best efforts to save them. Still, it would not take much time or thought to bring to mind instances of individual experience, or cases of record, in which the injuries done to abdominal viscera, and the shock incidental to a prolonged operation performed in recognized procedures for the relief of abdominal tumor, has been quite as severe as could be produced by a bullet in transit through the cavity, and yet the patient has survived. So it becomes a difficult matter to decide when to decline operative interference. Cases of recovery have followed surgical care of the wounds when many perforations of the intestines<sup>1</sup> were found, and in which solid viscera<sup>2</sup> have been traversed by the bullet; many

<sup>1</sup>Hamilton, Bull.

<sup>2</sup>Murphy.

cases have perished in which, after death, examination showed the simplest injury to repair, and indicated the probability of speedy recovery had the abdomen been opened at once and the wounds treated. One is almost tempted to say that all cases are entitled to the chance of life offered through operative procedure. It is hazardous to predict a fatal issue. However, if the abdominal wound is complicated with a severe injury of the spinal cord, or bad wound of the solid viscera, or so great a time has elapsed as to allow of extensive extravasation and infiltration, with consequent virulent inflammation, the probability is that the issue will be fatal.

In application I will present the following cases :

Mr. J. F., shot himself in two places in rapid succession with a 32-calibre revolver. I saw him four hours after the injury was produced, and found two bullet wounds, four inches to the left of the median line on the same line with each other and one and one-half inches apart; the lower wound was even with the umbilicus. One bullet had gone through the body; its exit posteriorly was just below the last rib and close to the outer edge of the erector muscle. There had been and still was considerable hemorrhage going on from the posterior wound. He had eaten a hearty dinner just previous to the shooting. The patient was moderately collapsed, pulse very fast and countenance pale. By the time he was anæsthetized and necessary preparations were made, darkness had come on, and the operation was done with the light from a single gas jet.

The two bullet wounds were joined by an incision and the fact of penetration demonstrated. An opening was then made in the median line four inches long through the abdominal walls. Considerable blood was found in the peritoneal cavity. This was removed and the wounded intestines sought for. These were easily found and the perforations quickly closed with a straight needle, carrying No. 1 silk thread. Five perforations were found and secured. On examining the posterior peritoneal surface a bullet perforation was found in it directly over the body of the left kidney. On passing the finger through it the kidney was found to be perforated by the bullet. The hemorrhage from the wound was at this time very slight. During this period operative procedures had to be discontinued several times to prevent the patient from choking during his attempts to evacuate the stomach, as he was vomiting large masses of meat and other food. The kidney was not removed. The wounds were closed, dressed anti-

septically and the patient put to bed. He rallied fairly well in a few hours and seemed to progress nicely for twenty-four hours, when he began rather suddenly to fail rapidly and died in collapse. There had been considerable bleeding from the posterior wound, and the patient died from hemorrhage from the wound in the kidney. It is to be regretted that the organ was not removed. The other wounds were comparatively simple in character and easily secured. There was but slight extravasation and the cavity was left quite clean.

P. J., aged 45 years; was shot while walking in the street on the night of July 4th. He was seen by me at the Presbyterian Hospital sixteen hours after the injury was inflicted. I found a large-sized bullet wound in the right iliac region, slightly below and two inches inside of the right anterior superior spine. The surface had been rendered aseptic and the patient anesthetized before I examined him. The edges of the wound were more ragged and more deeply discolored on the outer and upper portion, showing that the missile struck obliquely to the surface of the abdomen and that its direction was from the right and above. Considerable fecal matter was found in the wound. The man held his right thigh semi-flexed even when fairly anesthetized. The right half of the abdomen, the upper portion of the thigh and buttock was fiery red in color, the margin of the erythematous blush being well marked. The respiration was entirely thoracic, the abdominal walls hard and motionless. An incision was at once made in the midline after emptying the bladder of a pint of urine. As soon as the peritoneum was opened large quantities of a stinking ichorous serum poured out, bringing with it fecal matter and small pieces of potato undigested. This material was washed away by a free flow of mild boric acid solution. The wounded intestine was then sought, and after drawing out about six inches of badly inflamed tube, it was reached. It was a large perforation of the small intestine, but was secured by the continuous suture, without difficulty. All the folds of the bowel in the iliac fossa and pelvis were examined, but no other openings were found. A question of perforation of the bladder was raised, but a thorough examination with finger failed to find any. To further prove the uninjured condition of the bladder, it was distended with warm milk, but no leakage was noticed and the milk was allowed to flow away through the catheter. The external bullet wound was enlarged and its track followed by the finger. The missile barely entered the abdominal cavity at the fold between the abdominal walls and iliac fossa, and just outside of the femoral vessels, and was then lost in soft parts of the thigh on posterior surfaces. It evidently gouged out the convexity of the knuckle of intestine lying in its course.

After thorough cleansing, the wounds were all closed and drainage left in the abdominal cavity. It was now noticed that the patient had abdominal respiration and straightened his right leg. The operation was done in the presence of Profs. Gunn, Etheridge and Merriman and Drs. Talbott, Mellish, Ward and others. All expressed their belief that no other incision than that through the midline would have enabled the surgeon to as easily and positively repair the injury and cleanse the cavity. The man died sixteen hours after the operation. With such extensive extravasation and virulent peritonitis as was found, no other result could be anticipated. With an early operation I believe the recovery would have been prompt in a case with so simple a wound and the absence of any complication. The case certainly points to the necessity of prompt relief in these injuries. The post-mortem confirmed all the facts ascertained during the operation, and I have present a section of the bowel showing the wound and the condition of the suture used to close it.

One can fairly believe that the abdominal incision adds but little to the patient's danger, and if there be any, it is quite offset by the benefits accruing from a perfect knowledge of the wounded person's true condition, as is exemplified in the following case :

Dr. John I. Skelly of Potomac, Ill., reports, in the July number of the ANNALS OF SURGERY, a case of penetrating shot wound of the abdomen. The cavity was opened by median section, no injury to the intestines was found, the bleeding was controlled, the peritoneal wounds sutured and the patient recovered. The injury was done by a bullet from a .32 calibre revolver. Great shock was present in this case although no important viscera were wounded. Dr. Skelly refers especially to the great confidence in recovery, expressed by the patient, when assured that the intestines were not injured.

*What technical measures are best in the treatment of bullet wounds of the intestines, mesentery, stomach, kidney, spleen, liver and bladder?*

It is yet my firm conviction that in the great majority of cases the incision in the midline, will allow the most room for all the manipulations absolutely necessary on the surgeon's

part, and yet be conducive of rapidity of action. It will furnish the surest way of following the course of the bullet, and thereby enhance the certainty of securing all injured viscera in all cases of through and through perforation especially if the course of the ball is transverse, oblique or median. It will furnish the best way of reaching all parts of the cavity through which to insure perfect toilet of the peritoneum. Prof. McGraw's case shows there may be exceptions to what it seems should be the general rule. Here, as elsewhere, each case has its own indications and must be managed according to them.

It seems proper for me to refer to a few conditions found in the wound of the intestine itself dependent upon the character of the ball producing it, previous to passing in review the means to be adopted for its closure.

The character of the wound in the bowel depends greatly upon the size and shape of the bullet producing it, and much also upon the velocity of the missile. Round bullets moving rapidly make a clean cut, rather small wound with the minimum amount of bruising, so that they are comparatively easy to close. Rapidly moving conical bullets do much more damage than the round, still even with these, the great velocity makes the injury less severe than might be expected from such terribly destructive agents. The extent of bruising is greater, the edges of the perforation are more ragged, still if they strike the tube fairly in the lateral surface many such wounds can be safely managed without resection. The greatest amount of damage, in my experience, is done by the rather slowly moving missile be it either round or conical; these tear, mash and lacerate the tissues instead of making a clean punch, like the swift ones.

However made, the large proportion of perforations in the bowel will be well secured, and quite rapidly, by means of the continuous stitch, applied so as to invert the edges of the wound towards the lumen of the tube, by entering the needle, a safe distance, away from the margin of the wound and sewing over and over until all of it is covered with the opposite surfaces of the peritoneum held together by the stitches.

As the result of experimental research the following state-

ment was made by myself in 1885 in an address before the American Medical Association, written on this subject, "This way (that is the use of the continuous suture) of treating the bullet openings in the bowel is susceptible of much wider application than would appear possible at first glance. I am quite well satisfied that it will take the place of excision in not a few cases of quite severe injury. The torn edges of the wound can be turned in, and peritoneal surfaces fastened together, even in large wounds, with perfect confidence in the result of safe and secure adhesion following."

This statement has been borne out absolutely in my own experience since then in the human being, and I believe it is the experience of all other operators. In no instance in any of the reported cases submitted to surgical treatment, since then, do I remember that the operator has been called upon to make a section of the bowel. All seem to have trusted to the continuous suture over the inverted wound. The recoveries are a positive evidence of its success and none of the fatal cases show a failure to secure the bowel wound by its use. It apparently makes no difference whether the wound in the bowel is closed parallel to the course of the tube, or transversely or obliquely. The result is the same, provided the stitches are securely taken. Of course the most easy and most rapid method of procedure is the best to be adopted and of this the operator must be the judge.

With a through and through penetration of the cavity, we may expect to find clean perforations and the openings of minimum size in the intestine; with a single entrance wound, arguing diminished velocity of the bullet, the tube openings will be very likely ragged, bruised and difficult to repair without sacrifice of intestine.

If the perforations found in the bowel are situated fairly away from the mesenteric surface, little difficulty will be found in carrying out the manipulations necessary for their closure. Still in cases in which many perforations of the tube are close together, the intervening portions between the wounds, have their vitality so greatly impaired by contusion, that complete resection of the implicated portion of intestine will be required.

When the ball opening is directly at the mesenteric junction repeated instances of imperfect union followed by extravasation have occurred to me in experimentation. This kind of injury requires exceptional care in the application of the sutures, so that they include something more than the peritoneal covering, and do not include the larger blood vessels entering the coats in this position.

When the injury is so extensive as to positively require resection of the wounded portion, my experience from experimental inquiry, was positively in favor of two methods of procedure. 1st, cases in which the mesenteric border could not be saved, were most successfully treated, by making the section in healthy bowel tissue, and removing the injured portion with a triangular piece of the mesentery, the base of the triangle representing the length of intestines, removed. The first sutures are best introduced at the mesenteric border of the divided ends of the intestines, because this plan furnishes more room, in which to make sure of the engagement of sufficient tissue in the loop of the suture, to make a fast and secure hold, than there would be if the other portions of the circumference were united before reaching this border. Failure to get good union, and to avoid extravasation, followed in every case in which this plan was not adopted.

Neither in man nor animal, have I found it necessary to introduce more than one row of sutures, either in the repair of single perforations, or in complete resections, provided the hold of the suture included about one-third of an inch of peritoneum with underlying muscular coat, and the sutures were placed about one-eighth of an inch apart.

In no instance, in my experience, except when drawn too tightly, have the sutures failed to perfectly close the opening so that at the end of twelve hours sufficient plastic adhesion had taken place to resist powerful hydrostatic pressure, and, that too, in cases in which there were thirteen perforations in eighteen inches of intestine.

That method which safely accomplishes the object of surgical interference, in the quickest possible time, and with the least possible disturbance of the viscera locally, or in general, is the best to adopt; saving of time alone is of vital importance to the patient.



The edges of the divided mesentery should be sutured and all raw surfaces covered with peritoneum by means of stitches, with very fine catgut or silk, in order to avoid leaving any secreting surfaces free in the peritoneal cavity.

2d. Cases in which the mesenteric or nutritive border can be saved. A plan which I have successfully adopted experimentally is as follows: The wounded part is cleanly cut out leaving the uninjured mesenteric portion. From this the mucous membrane is stripped, and the muscular coat with its peritoneal covering, drawn downwards in a loop. This loop is closed with stitches and the bowel circumference remaining, fastened as in complete resection. This method produces no flexure of the bowel and does not interfere with the free flow of blood in the vessels coming from the mesentery.

The most reliable and safest clamps, for use in holding the bowel, during the manipulations of making a resection, were found in experimentation to be the fingers of an assistant, and further experience has not changed the result of that observation; they can do the least damage, and produce the least amount of shock, and will prove an intelligent aid to the operator.

The wounds of the large intestine can be rapidly, and usually easily repaired by means of the continuous stitch on account of their large calibre and comparatively thick walls. Here, if anywhere, the wounded bowel can be reached through an enlargement of the external bullet opening, as has been successfully done in one case by Prof. McGraw, of Detroit, but this is only possible, in my opinion, in cases in which the shot is a direct antero-posterior one, over the course of the large intestines, and does not touch any small intestine. It seems impossible to me so easily to find the injured parts, or so rapidly repair them; or to carry out so successfully proper cleansing of the cavity, through any other incision than the median section, in oblique or through and through penetration in any transverse plane of the abdominal cavity. My belief is based upon trials on the cadaver, and living animals, and wounded men. No other incision, to my mind, gives such perfect command of the entire cavity.

In one instance an incision extending over the entire length

of the lateral surface of the abdomen and fully to the midline of Poupart's ligament, failed to enable the operator to find the vessel from which the fatal hemorrhage came. The track of the bullet could be traced to the opposite side of the cavity, but the intestine could not be drawn through this lateral incision so as to properly explore the course of the ball. There was no wound of exit. It seems very probable that the median section, by bisecting the bullet's course, and allowing easier access to the cavity would have made this case, as it will others, simpler to manage, at least.

It is a matter of record in surgical experience that the wounds confined to the large intestines have often been recovered from without surgical interference, still, it is certainly probable that the number of recoveries will be increased, and rapidity of restoration to health more surely provided for, by closing the wound in the intestine and cleansing the cavity at once, and without adding materially to the patient's danger.

In animals, and probably likewise in man, a perforation of the great omentum is followed, sometimes, by a universal extravasation of blood throughout the meshes of the mass, producing a condition that requires ablation of the greater portion, after proper ligation. The end of the stump left after separation can be covered by sewing adjoining surfaces of peritoneum over it. All slits or openings in the mesentery should be carefully closed with the continuous suture so as to avoid contaminating secretion into the peritoneal cavity.

The wound in perforations of the stomach is occasionally difficult to find, but when found, no difficulty is met with in applying the means of closure. The continuous suture has not failed to securely fasten them, and in every instance they have been followed by speedy recovery unless they were complicated by severe injuries to other viscera.

There are on record quite a number of cases of penetration or perforation of the liver alone followed by recovery. If in doubt, with a posterior wound of entrance, enlargement thereof, with antiseptic care and dressing, would be justifiable. With an anterior wound, the course pursued by Dr. Murphy, of Chicago, in a case reported by him, was followed by recovery. Median section was made, the cavity cleaned of blood,

and the wounds on the surface of the liver drawn together with catgut sutures. In my experience, wounds of the liver were managed in the same way and did well if the sutures were deeply placed.

Wounds of the spleen bleed freely and are difficult to manage with sutures on account of the brittle nature of the spleen tissue, still sutures rather deeply placed will hold the edges of the perforation in apposition. If badly lacerated, the many reported cases of recovery, after complete removal of the spleen for injury, rather indicate that extirpation is the best means of treatment in such injuries.

Perforation and wounds of the kidney, from the character of the organ and the profuse hemorrhage from its torn surface, from the danger of urinary infiltration and decomposition, seem impossible to manage without extirpation, especially if injured by an anterior wound of entrance. In one case of my own a complete perforation of the kidney was found. It was decided to leave the kidney. The patient did well for about twenty-four hours and then succumbed to a profuse hemorrhage from the wounded organ. It seems the chances would have been better with it out.

If the kidney is wounded, with posterior opening only, and enlargement thereof shows the injury to be confined to this organ alone, the cavity of the abdomen is not perforated, and recovery is possible either with or without removal of the organ.

Perforation or damage done to either the liver, spleen or kidneys, accompanying similar injuries to the small intestines, greatly increases the gravity of the case, and probably very few cases will recover, whatever is done for their relief.

Sir William MacCormac has positively demonstrated the success, following abdominal section in ruptures of the bladder, in order to securely suture the wound. It is proper to infer that bullet perforation of the viscus can be quite as easily secured in the same way.

The results of the experience of Varick, of New Jersey, and Wylie, of New York, should always be borne in mind. They have demonstrated that hot water introduced into the peritoneal cavity accomplishes three purposes of great moment: relief of shock, arrest or abatement of hemorrhage, and cleansing of the cavity.

I think carbolized silk of fine size is the best material to use for the bowel suture, simply because perfectly reliable catgut cannot always be obtained, and the risk is too great, if there be the least likelihood of any strand giving way. No doubt, well prepared catgut may answer every purpose, but the silk never fails to do the work required of it satisfactorily.

If asked what are the points most likely to be neglected or slighted in such an undertaking as giving surgical relief to a case of perforating gunshot wound of the abdominal viscera, my attention would be drawn to the items leading to failure in experimentation, and the conditions mentioned as found in the repeated unsuccessful cases in man. Among these would come first the paramount necessity of searching out and securing all bleeding vessels, dependent upon the danger of immediate or secondary hemorrhage. Hamilton, of Washington, tells us that his successful case passed through a period of extreme danger, in the last days of his illness, from the formation of a blood tumor. Murphy, of Chicago, reports a case lost from post-peritoneal bleeding. And in this case post mortem showed all the intestinal wounds thoroughly closed and water-tight. I have reported a case in which the immediate cause of death was kidney hemorrhage.

It is, no doubt, a hazardous ordeal to put a patient through, to examine the intestines from one end to the other in order to be well satisfied that no perforation has been over-looked, yet it is far more hazardous (in fact the result will be surely fatal) to leave an opening in the small intestines untreated. In some of the reported cases wide open bullet wounds have been found with their surrounding fecal extravasations and contaminated blood.

It is to me extremely doubtful if all the wounded parts will be found, in an estimated transverse plane drawn through the demonstrated track of the bullet, especially if the missile implicates the ever gliding and moving small intestines. I am not prepared to believe that a supposed probability as to the seat of injured parts, should take the place of a regular, carefully made and satisfactory search for the wounds, and yet I would very carefully avoid practicing, or advising any procedure that might unnecessarily add to the shock already pres-

ent. We do not know all that it is best to do yet, and still we do know that failure to close all the wounds means death to the patient, and some risk must be taken to avoid so great a hazard.

It needs no argument or demonstration to prove the harm resulting from tight suturing. It has been my experience to see in animals the edges of several wounds slough away to the extent of the bowel tissue included in the sutures, followed by extravasation, making a failure out of a case that otherwise gave good promise of being a success. The temptation is great to be over-sure of good union. In my experience peritoneal surfaces need only be laid in contact with each other and kept quiet for a few hours in order that adhesion may occur. The paralyzed condition of the bowel at the seat of wound from the injury, in itself favors this desirable quiet.





