Penetrating Wounds of the Abdomen.

By Captain John Fraser and Captain H. T. Bates.

Royal Army Medical Corps.

(Report to the Medical Research Committee.)

We have lately had an opportunity of observing the operative results of a number of cases of penetrating wounds of the abdomen. So much debate has centred around the treatment of these cases that we believe it may be of interest to record some of the observations which we have made.

Penetrating Abdominal Wounds Considered Locally.

Wounds of the Stomach.

We have had a total number of six cases, and they illustrate wounds of almost every possible portion of the stomach.

Morbid Anatomy.—The degree of damage which is sustained depends on two factors—the nature of the projectile, whether shell fragment, bullet, or bomb, and the part of the stomach which is injured. In regard to the first qualification, shell fragments produce, almost invariably, the most extensive destruction, for combined with the irregularity in their shape there is a high degree of velocity in the speed with which they strike the part. These facts are illustrated both by text and diagram in Case 5. Bullets generally behave as they do in other soft tissues, that is, with a small entrance wound and a larger wound of exit; but, as will be shown later, the amount of damage produced by a bullet is very closely related to that part of the viscus which is struck, e.g., bullet wounds of the pylorus are more extensive than bullet wounds of the body of the stomach. Bomb wounds in their degree occupy a position which is midway between the shell and the bullet wound; the bomb fragment has the irregularity of the shell fragment, but its velocity is comparatively small. The region of the stomach which is injured is all important, and these remarks apply to bullet wounds, as shell and bomb wounds do not appear to be so much influenced by position. Bullet wounds in the centre of the body of the stomach have a comparatively small entrance and a slightly larger exit wound. A bullet wound in
the region of the pylorus has a relatively small entrance wound, but the exit wound is usually large and pouting; the greater degree of severity would appear to depend on the fact that the projectile passes through the thicker musculature in the neighbourhood of the pylorus (see Case 6).

Bullet wounds involving the greater or lesser curvature are always extensive; the lines of force are such that accompanying the actual wound there is extensive splitting and tearing of the vasculature of the stomach wall (see Case 5). The haemorrhage is not severe unless the wound has actually involved one of the larger vessels (coronary or gastro-epiploic), and in this respect stomach wounds differ from wounds of the small intestine. There is usually haemorrhagic infiltration of the peritoneal and muscular coats, and it is important to notice that there are points of tissue separation and actual tissue necrosis for a considerable distance around the wound.

Clinical Features.—Wounds of the stomach demonstrate the clinical features which one associates with wounds of the hollow viscera of the abdomen generally; there is pain, sickness, collapse, rigidity of the abdominal wall, with tenderness on pressure; but in addition to these general features there are certain distinctive signs. Sickness is usually more pronounced than in wounds of the other abdominal viscera, and in the vomited matter it is rarely that one fails to find the presence of blood. The degree of collapse is less marked than that found in intestinal injuries, but whether or not this is related to the comparatively small amount of haemorrhage one cannot say.

It is interesting to note that while the pulse and respiration rates are both increased, the respiration-rate has proportionately increased more rapidly than the pulse-rate. The degree and the variety of the clinical features are influenced considerably by the situation of the lesion. Pain would appear to be more intense when the cardiac or pyloric ends of the stomach are involved; it is correspondingly less so when the wound is related to the body of the stomach.

Wounds of the curvatures of the stomach, with the greater destruction which invariably accompanies them, are associated with severe symptoms of collapse. The clinical features are also influenced by the condition of the stomach at the time of injury; if the stomach contains a quantity of food the wound is followed by more intense clinical features than if the organ had been empty.

Treatment.—These remarks are, of course, confined to operative treatment. If by examination we are confident that the
stomach is injured, we have found it advisable to employ a left rectal incision, either splitting or retracting the muscle; this incision gives good approach to any part of the organ, occasionally it is necessary to enlarge it laterally. When the situation of the wound is doubtful we have used an incision parallel to the left costal margin. After exposure an examination is made of the anterior surface and lesser curvature of the stomach, and of the region of the cardiac orifice. The anterior layer of the great omentum is torn through and the greater curvature and the posterior surfaces are thoroughly passed in review. We have met with conditions which called for three different lines of treatment, either singly or combined, the different lines of treatment being: (1) simple suture (Cases 1 and 2); (2) gastro-enterostomy (Case 5); (3) pylorectomy or resection of a portion of the stomach, usually combined with a gastro-enterostomy (Case 6).

In regard to simple suturing some situations are infinitely more difficult of access than others; for example, in a wound at the cardiac end of the stomach and near the lesser curvature we have experienced extreme difficulty in closing the opening. It has been our principle to excise the wound edges, thus preparing a more suitable surface for suturing and healing, afterwards closing the wound with a primary approximating and a secondary invaginating linen thread suture. Gastro-enterostomy is indicated when there is an extensive wound of the dependent part of the greater curvature of the stomach; the anastomosis may be done on the principle introduced by Kocher, but more usually the position and type of anastomosis will have to be modified by the existing conditions. Wounds of the pyloric end of the stomach are often so extensive that it is necessary to remove the damaged portion of the stomach with closure of the open ends and a secondary gastro-enterostomy.

If the peritoneal surface has been grossly soiled with stomach contents we have washed out the cavity, draining it suprapublically with a Keith’s drainage-tube. In perforation of the posterior wall of the stomach, with infection of the cavity of the lesser sac of the peritoneum, we practise drainage of this space by a tube passed posteriorly above the pancreas.

**Synopsis of Cases.**

*Case 1.*—Pte. B. H., West Riding Regiment. Wounded by a rifle bullet at 10.30 a.m., he was admitted to hospital at 2 p.m. and was operated on within four hours of receiving the wound. The entrance and exit wounds were in the left epigastrium and left
Penetrating Wounds of the Abdomen

loin. There was pain and sickness, the vomited matter being blood-stained, and there was the usual accompanying abdominal rigidity. The general condition was good and there was no marked collapse. The abdomen was opened in the left rectus line; perforations were found through the anterior and posterior walls of the body of the stomach; in addition the jejunum was perforated just beyond the duodeno-jejunal flexure. The perforations were closed with sutures and the usual drainage was established. The patient made an uninterrupted recovery and was discharged to the base.

Case 2.—Pte. A. F. H., Royal Engineers. This man was wounded by a rifle bullet at 6.30 p.m. on the night of August 28, 1915, and admitted to hospital at 11 a.m. August 29. The entrance and exit wounds were in the left epigastrium and left loin; great abdominal pain was complained of and the patient was practically pulseless. The abdominal cavity contained a quantity of blood and there was an effusion of blood into the left pleural cavity. So complete was the collapse that operation was delayed for three hours, and during that period various restorative measures were carried out. When operation was performed, access was gained to the abdominal cavity by an incision parallel to the left costal margin. The abdominal cavity was full of blood, there was a wound of the stomach where the lesser curvature joins the oesophagus and from it stomach contents were escaping; the profuse hemorrhage had apparently originated from a branch of the coronary artery. With great difficulty the perforation was sutured; the peritoneal cavity was washed out and drainage secured. The patient died about two hours after the completion of the operation. Post-mortem examination showed that in addition to the wound of the stomach the lower lobe of the left lung was perforated, while the pleural cavity contained a large quantity of blood.

Case 3.—Pte. B. W., King's Royal Rifles. Wounded at 7 p.m., September 11, he was admitted to hospital at 10 p.m. of the same date. There were entrance and exit wounds in the left back and loin. There were the usual signs of injury to the abdominal viscera; there was a considerable degree of collapse, the pulse-rate on admission being 130. The abdomen was opened by an incision running parallel to the left costal margin. It was found that the projectile had grazed the left end of the greater curvature of the stomach; in addition there was a perforation of the splenic flexure of the colon. The perforations were closed with sutures and drainage established. On the sixth day a fecal fistula developed from the colon wound, but otherwise a good recovery was made.
Case 4.—Pte. H. W., Rifle Brigade. Wounded at 10 p.m., August 29, 1915, he was admitted to hospital at 2.30 a.m. of the following day. On admission it was found that the collapse was so intense that any operative procedure was entirely out of the question; he died a few hours after admission. Post-mortem examination showed that there was a large tear in the greater curvature of the stomach; in addition the bullet had passed through the left lung, and the pleural cavity contained a quantity of blood. This case was not operated on, but we have included it to show the greater degree of severity and collapse which follows wounds of the greater curvature of the stomach. This patient was admitted about four hours after sustaining his wound, but even at that early period he was entirely beyond operative aid.

Case 5.—Pte. G. H., York and Lancs. There was a shell wound of the left hypochondriac region sustained at 8 a.m. of September 23, 1915; he was admitted to hospital at 4.30 p.m. of the same day. There were all the signs of injury to the abdominal viscera and in addition it was obvious that the patient was bleeding profusely internally. The abdomen was opened through the left rectus; it contained a large amount of free blood mixed with gas. Along the greater curvature of the stomach there was a wound about two and a half inches long; the position of the wound was

---

Fig. 1 (to illustrate Case 4).—Bullet wounds of the greater curvature of the stomach.
s\uch that it permitted of a gastro-enterostomy being done between
the open wound and the jejunum. The edges of the stomach
wound were excised. In addition to the stomach wound there were
seven perforations in a two and a half feet length of small intestine,
necessitating resection and lateral anastomosis. The patient sur-
vived the operation for about eight hours and then died of collapse.
The case demonstrates the suitability of a gastro-enterostomy under
certain conditions.

Fig. 2.

Fig. 3.

Figs. 2 and 3 (to illustrate Case 6). Fig. 2, anterior view of the pylorus, showing
the small entrance wound. Fig. 3, posterior view of the pylorus, showing the large
exit wound.

Case 6.—Cpl. A. C., King's Royal Rifles. This man was
wounded at 6 p.m., September 24, 1915, and he was admitted to
hospital at 1.30 a.m. of the following day. On admission there were
all the signs of injury to the abdominal viscera, but the collapse was too great to permit of immediate operation; operation was therefore delayed for two hours. Upon opening the abdomen it was found to contain a large quantity of blood, there was a perforation through the antrum pylori with a small entrance, and a large blown-out exit wound; in addition there were five perforations in the upper end of the jejunum. The damaged portion of stomach, the pylorus and a portion of the body of the stomach were removed, the open ends were closed, the damaged loop of intestine was resected, an anastomosis done, and a gastro-enterostomy performed between the body of the stomach and a loop of jejunum. This patient lived for twenty-four hours; during that period his pulse remained good and there was no sickness; he died eventually with extreme suddenness. This case illustrates the occasional necessity of removing a portion of the stomach.

<table>
<thead>
<tr>
<th>Results of Stomach Cases.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>6</td>
</tr>
</tbody>
</table>

Wounds of the Small Intestine.

Under this heading we have a total of twenty-one cases to consider.

Morbid Anatomy.

Among the series we have had cases of bomb, bullet and shell wounds, and each of these varieties has distinctive features. Bomb fragments produce small and multiple wounds with slight evagination of the edges, but with a marked tendency to surrounding ecchymoses and haemorrhage (Cases 11 and 23).

Bullet wounds, when caused by a projectile travelling at a great velocity and fired at a comparatively short range, are small perforations, with slightly larger exit than entrance wounds (Case 22). Bullets travelling at a lower velocity result in considerable destruction of the gut wall. When the projectile passes across the long axis of the gut it may pierce it through and through, but sometimes it tears it open as though it had been cut by a knife (Case 24). Bullets passing obliquely through or in the long axis of the gut produce extensive injuries; if in the long axis of the gut,
Penetrating Wounds of the Abdomen

the bowel is torn completely open (Case 13); if the intestine has been struck obliquely, there are two large perforations, one on each side with an intervening bridge of tissue (Case 14).

The damage produced by shell fragments is usually very extensive (Case 12), but if the force of the fragment is nearly spent our experience has been that the wound is no larger than the fragment which caused it—in one instance we have found the fragment of shell embedded in the gut wall (Case 18).

As regards position, wounds of the free edge of the gut are more extensive than those which occur at the mesenteric border. Correspondingly, wounds of fixed parts of the small intestine, e.g., duodeno-jejunal flexure and the ileo-caecal junction, are less extensive than wounds of the freer portions of the gut.

Hæmorrhage from the small intestine is as a rule severe; especially when the wound has occurred in the jejunum. It is remarkable how rarely there is a massive escape of contents from the lumen of the gut—we have never seen it occur to any marked degree; apparently there is a complete inhibition of peristalsis for some time subsequent to the injury. Further, the less the damage to the gut and the fewer the number of perforations, the more likelihood is there of extensive peritoneal soiling. We believe the converse holds good.

When the gut is injured it is rarely that the mesentery escapes, and one is exceedingly apt to overlook a wound in this region. When a large mesenteric vessel is cut the haemothage is rapidly fatal—but even in division of a comparatively small vessel or series of vessels the haemorrhage is progressive, a characteristic which is curiously peculiar to intra-abdominal bleeding. When the blood-vessels in the mesentery are damaged, one is faced with the question whether the viability of the associated gut is or is not interfered with. In this relation we have observed that while interference with the mesenteric blood may not actually endanger the viability of the gut, that portion of gut is particularly liable to a subsequent distension which may pass on to an actual paralysis.

There is nothing characteristic about the superficial wound. Unless one is prepared for it, one is at first apt to overlook the fact that bullet wounds of the buttock are liable to be followed by evidences of injury to the abdominal viscera.

Clinical Features.—The clinical features are those of commencing peritonitis coupled with the evidences of a rapid and progressive haemorrhage. The facial expression is one of intense distress, pallor may become evident and deepen. The pulse
becomes progressively and rapidly quicker and weaker. General abdominal pain is complained of, the pain being accentuated at intervals. There is frequently retention of urine. Sickness comes on, and during the attacks of vomiting the abdominal pain is intensified. The temperature at first falls, and after some hours begins to rise. As a rule, there is fixation of the abdominal wall, and the respirations are largely thoracic in type. Palpation elicits general tenderness, and palpation confirms the muscular rigidity which exists. Under the influence of morphia, and sometimes when the intra-abdominal bleeding is profuse, we have seen the muscular rigidity of the abdominal wall almost disappear. By percussion it is frequently possible to demonstrate the presence of dulness in the flanks and the diminution of liver dulness.

In later and untreated cases the clinical features are those of acute general peritonitis.

Treatment.—Later there are described measures which we have carried out preliminary to all abdominal operations for this class of case, measures which are intended to antagonize the shock and loss of blood which occur. As a preliminary to operating for perforating wounds of the small intestines, these precautionary methods are of the highest practical importance, as the amount of shock and the loss of blood in these cases are often exceptionally severe.

To open the abdominal cavity we have almost invariably used a middle-line incision—it is important that there should be no hesitation in making the incision one of considerable length. In localizing the sites of injury we have followed a well-defined routine. After opening the abdomen, the cecum is identified, and from it the small intestine is traced upwards, beginning with the lower end of the ileum. As each perforation of the gut is exposed, it is wrapped up in a small moist swab; to one side of the swab a length of tape is stitched; this is slipped through the mesentery, and doubled twice round the gut covered by the swab; in this way each perforation is marked, and at the same time there is less chance of a massive infection from the injured part. The whole length of the small intestine must be examined before any decision as to treatment is arrived at—there is nothing more disconcerting than to deal with a perforation by resection and to find that a few inches farther on there is another perforation which could have been included in the same procedure. When the degree of damage to the gut has been brought under review, there are three varieties of operative treatment which may be followed; these are:
Penetrating Wounds of the Abdomen

(1) Simple suture of the perforations; (2) resection of the damaged intestine followed by a lateral or end-to-end anastomosis; (3) resection of the damaged intestine with an accompaniment of a temporary enterostomy.

(1) Simple Suture of the Perforations.

In the series of cases which came under our notice a small minority proved suitable to be dealt with by simple suture. In order to be suitable it is essential that the wound is small, without damaged edges and with an intact mesentery. Bomb fragments cause wounds which are most ideally suitable for suture.

The method has the obvious advantages of speed and simplicity of technique. There are certain distinct disadvantages. The suture may result in considerable narrowing of the gut lumen, and when there are a number of similar sutures within a short distance of each other the multiple narrowing becomes a very real objection. The second objection is that a suture, unless very complete, is apt to be followed by a local sloughing of the part. The edges of the perforation are devitalized and the microscope has shown that actual necrotic changes can be distinguished in the tissues for some distance around the wound.

In the suture operations which we have done we have not excised the wound edges, and we have used linen thread as the medium for stitching (Cases 7, 8, 9, 10, and 11).

(2) Resection of the Damaged Intestine followed by Lateral or End-to-end Anastomosis.

There are certain indications which necessitate this method of treatment: multiplicity of the perforation, extent of the degree of the perforation and involvement of the related mesentery. We have distinctly favoured this method of treatment, and we have preferred it at times when another method might have been chosen. Two disadvantages have been quoted: the complexity of the technique and the time which the operation entails. In regard to the second objection we question if it takes any longer to complete a resection and anastomosis of gut than to do a multiple suture operation. The advantages are very great; the operation is a complete and a thorough one, the risk of damage following a mesenteric involvement is minimized; there are not the possibilities of local areas of sloughing as are so apt to occur in suture operations, and there is less possibility of subsequent stricture. Having
weighed the choice of the operation the question next arises whether the anastomosis is to be a lateral or an end-to-end one. When we began this work we favoured and used an end-to-end anastomosis, on the ground that it could be accomplished in a shorter period of time than the lateral anastomosis. We discovered that this method was apt to be followed by a certain degree of paresis in the proximal segment with subsequent distension and eventual obstruction. On one occasion we had to perform a second short-circuiting operation to overcome the obstruction (Case 13).

The gut appears to be predisposed to the distension from various causes: the general degree of nerve shock and more especially of sympathetic nerve shock, the paresis of Auerbach's plexus as a result of the blow, the presence of blood in the peritoneal cavity, and the degree of peritonitis which invariably is present. As a result of this disadvantage we began to employ a lateral anastomosis and from it we have had undoubtedly greater satisfaction and better results. In point of time, the lateral anastomosis takes a few moments longer in so far as it involves closing the open ends of the gut, but it apparently largely overcomes the possibility of distension of the proximal segment. We do not intend to enter into any details of the operation beyond mentioning that when the resected gut involves the extreme lower end of the ileum we have anastomosed the proximal bowel to the centre of the transverse colon. Short-circuiting, so to speak, by a unilateral short circuit the caecum, ascending colon and hepatic flexure, there are obvious mechanical advantages related to this method (Case 14).

(3) Resection of the Damaged Intestine with the Accompaniment of a Temporary Enterostomy.

Fortunately we have only had occasion to have recourse to this most unsatisfactory procedure in one instance (Case 25). It is justified when rapidly developing collapse necessitates that the operation be finished as quickly as possible: the damaged bowel is cut away and the open ends are sutured to the skin wound.

When there is gross soiling of the peritoneal cavity we have washed out the abdominal cavity with hot saline solution, draining subsequently suprapublically with a glass Keith's tube.

**SYNOPSIS OF ILLUSTRATIVE CASES.**

**Case 7.**—Pte. B. T., Middlesex. There was an entrance wound in the left umbilical region; there was no exit wound apparent. There were signs of injury to the abdominal viscera but the general
condition was good. From the wound a coil of small intestine was prolapsed. At the operation the wound was enlarged; two perforations were found in the lower end of the ileum; the perforations were closed with purse-string and inverting sutures. Beyond a subsequent slight infection of the retroperitoneal tissues which required drainage, the patient made a good recovery.

Case 8.—Pte. B. H., West Riding Regiment. Entrance and exit wounds were caused by a bullet received four hours before admission; the general condition was good. Operation revealed two perforations of the jejunum just beyond the duodeno-jejunal flexure; these were closed with purse-string and invagination sutures. This case in addition showed two perforations of the stomach. Drainage was secured. The patient made a good recovery.

Case 9.—Pte. P. H., Northumberlands. This patient was wounded on the 26th of the month, but owing to military exigencies it was the evening of the 29th before he was admitted for operation; there was then an entrance wound below the umbilicus, together with all the evidences of extensive general peritonitis. It was doubtful whether operation was advisable, but it was decided to attempt it. A single perforation was found in the lower end of the ileum; this was sutured and drainage was secured. Subsequent to the operation the patient improved considerably; he apparently was on the road to recovery, the bowels moving well, when a week after the operation he died suddenly from what apparently was heart failure.

Case 10.—Pte. T. S., East Lancs. There were entrance and exit wounds, the bullet having entered the right buttock and come out anteriorly below the umbilicus. There were the usual evidences of injury to the abdominal viscera, and the general condition was fair. Operation showed a single perforation in the upper end of the ileum; there was extensive soiling of the peritoneal cavity and a commencing general peritonitis. The perforation was closed by suture. Four days after operation the patient succumbed to the general peritonitis which was present.

Case 11.—Pte. A. H., Black Watch. This man was wounded by a bomb explosion and there were a number of entrance wounds in the left flank. There was intense shock—pulse being 150. A number of fragments had entered the abdominal cavity and there were all the signs of injury to viscera. In addition, two fragments had entered the left lung and a third entered the spinal cord, producing complete paraplegia below the eighth dorsal segment. After waiting some hours for a possible improvement operation was
FIG. 4 (to illustrate Cases 11 and 23).—Bomb wounds of the small intestine. Note the comparatively small size of the wounds, the surrounding ecchymoses, and the suitability of such cases for suture.
carried out. The abdomen contained a large amount of blood; there were four perforations in the jejunum about eight inches below the duodeno-jejunal flexure; each was closed by suture. In addition the transverse colon was perforated at its centre, in the descending colon there were six through-and-through perforations; these wounds were sutured. The abdomen was washed out and drained suprapubically and in the left flank. As far as the abdominal condition is concerned we believe we are justified in
looking on this case as a success; his eventual history, however, shows that he ultimately died of a gradual ascending spinal meningo-encephalitis secondary to the infected wound of the spinal column.

The above cases are illustrative of the suture operation.

Case 12.—Pte. G. H., Yorks and Lancs. In this case the injuries were the result of a shell wound. There was intense collapse. The abdominal cavity was filled with blood, there were seven perforations in a two-and-a-half-foot length of small intestine (upper end of ileum); practically all of the perforations were very large wounds. Three feet of small intestine were removed and a lateral anastomosis completed. In addition the stomach was extensively torn, necessitating a gastro-enterostomy. The patient survived for eight hours and died of collapse.

Case 13.—Pte. W. G., Seaforth Highlanders. On admission the patient was collapsed, there was progressive hemorrhage from both superficial wounds, and general abdominal rigidity. The operation was performed under spinal anesthesia. The deep epigastric artery of the left side was severed, hence the superficial bleeding; the abdominal cavity was full of blood. In the upper end of the ileum there were three perforations—two small and one exceedingly large, opening up the gut for about one and a half inches. Nine inches of gut were removed and an end-to-end anastomosis completed. Forty-eight hours later signs of obstruction developed and the abdomen was again opened under spinal anesthesia; the proximal segment of gut at the anastomosis was distended and there was a large effusion of blood into the mesentery of this portion of the gut. A lateral anastomosis was done, short-circuiting the end-to-end suture. Patient made an uninterrupted
recovery; two months later we have heard from him as being in excellent health.

Case 14.—Pte. L. T., Black Watch. This man was wounded in the right buttock and six hours after having received the wound he was admitted to hospital; there were all the signs of injury to abdominal viscera. The operation was done under spinal anaesthesia. When the abdomen was opened a perfect fountain of blood escaped; in the lower two feet of ileum there were six perforations, in two instances the gut was shattered to pieces. The damaged intestine was removed and a lateral anastomosis completed between the ileum and the centre of the transverse colon. Patient made an uninterrupted recovery and three months later he informed us that he was enjoying excellent health.

Case 15.—Cpl. A. C., King’s Royal Rifles. Seven and a half hours elapsed since receipt of a bullet which had passed through the abdomen from side to side. There was intense collapse and operation was delayed for two hours. At operation there were found to be five large perforations in the upper part of the jejunum. In addition the transverse colon was torn across and the stomach was almost divided in two places. The damaged loop of small intestine was removed, and a lateral anastomosis completed; the stomach wounds were repaired and a gastro-enterostomy done, the damaged colon was brought out and a colostomy completed. The patient

Fig. 7 (to illustrate Case 14).—Two feet of the lower ileum injured by rifle bullet. Two portions of the gut have been entirely destroyed by the projectile.
stood the operation remarkably well and he survived for over twenty-four hours; during that time there was no sickness and his pulse remained good. He then suddenly collapsed and expired.

**Case 16.**—Pte. E. H., King's Royal Rifles. The wound had been sustained in the right loin and the bullet had taken an oblique path, being embedded below the left costal margin. Fifteen hours had elapsed since receipt of the injury and the collapse was intense. After waiting some time and taking measures to overcome the collapse, it became obvious that there would be no improvement and that the patient was bleeding rapidly internally. The abdomen was opened; eighteen inches from the duodeno-jejunal flexure the gut was torn across in three places, and there was profuse bleeding from a large branch of the mesenteric artery. The damaged gut was resected and the bleeding arrested. The patient died thirty-six hours after operation. Post-mortem examination showed no other lesion and death was due to haemorrhage and collapse.

**Case 17.**—Serjt. S. P., Worcesters. The entrance and exit wounds were in opposite flanks. There was complete collapse, seventeen hours having elapsed since the receipt of injury. There were all the evidences of general peritonitis and the abdominal cavity contained a quantity of fluid. Operation was conducted under spinal anaesthesia. The peritoneal cavity was found to be full of blood. In two and a half feet of small intestine (lower end of jejunum) there were seven perforations, several of them tearing the gut entirely across. During the operation there was progressive bleeding from the retroperitoneal tissues; its source could not be found. After the operation the patient steadily sank and died ten hours later.

**Case 18.**—Pte. A. H., Lincolns. Shell wound. There were entrance and exit wounds in the right epigastrium and left flank; there were all the signs of injury to the abdominal viscera, but the degree of collapse was not marked. Operation revealed the abdomen to be full of blood and gas; twelve inches of jejunum were extensively damaged by six perforations; in the wall of the gut the fragment of shell was embedded. The transverse colon was torn across at its centre. The damaged small intestine was removed and a lateral anastomosis completed; the perforated transverse colon was converted into an efficient colostomy. Patient made an uninterrupted recovery.

**Case 19.**—Pte. H. B., Rifle Brigade. On admission this patient showed entrance and exit wounds from the right buttock to the left hypochondrium. There was profuse external haemorrhage. The
Penetrating Wounds of the Abdomen

man was practically pulseless, but he improved somewhat after the intravenous transfusion of saline. There were all the signs of a generalized peritonitis. Operation was conducted under spinal anaesthesia, but the patient succumbed before any operative procedure could be carried out. Subsequent investigation showed that there were ten wounds throughout the small intestine, nearly all of which had torn the gut entirely across. For a distance of six inches in one part the lumen of the gut was entirely destroyed. In addition, the iliac colon was divided and the internal pudic artery was severed as it lay in Alcock's canal.

Fig. 8 (to illustrate Case 18).—A length of jejunum removed for injury by a fragment of shell. The intestine showed six perforations, and a fragment of shell was found embedded in the wall of the gut.

Case 20.—Pte. H. C., Wiltshire Regiment. The entrance and exit wounds were from side to side of the abdomen, and from the exit wound there was a considerable protrusion of omentum. On admission the general condition was good, but there were all the evidences of injury to the abdominal viscera. When the abdomen was opened the cavity was found to be filled with blood; there were seven perforations in the upper four feet of jejunum and in two instances the gut was shattered to pieces. The damaged gut was removed, and as the proximal portion was too fixed to permit of a lateral anastomosis an end-to-end suture was carried out. The patient died forty-eight hours after operation. Post-mortem examination revealed an intense peritonitis, especially in the upper part of the abdomen, and this apparently was the cause of death.
Case 21.—Cpl. B. A. E., Durham Light Infantry. There was an entrance wound in the left buttock; there were the signs of injury to the abdominal viscera, together with symptoms of intense collapse, pulse being 130. Ten hours had elapsed since the injury was received. The abdomen was opened in the middle line under spinal anaesthesia. There was an immense effusion of blood. Three feet of the ileum were found to be extensively damaged and torn with eight perforations. The damaged gut was removed and a lateral anastomosis completed. The patient succumbed a few hours after operation.

Fig. 9 (to illustrate Case 22).—Four feet of gut containing perforations from a machine-gun bullet. The bullet has passed with a high velocity through various coils of gut, passing across the long axis of the gut. The resulting damage is not extensive.

Case 22.—Pte. R. J. W., Irish Guards. Patient was shot at close range by a machine-gun bullet. He was operated on within two hours of receiving the injury, and his general condition...
was good; there were all the signs of injury to the abdominal viscera. Operation showed that the abdominal cavity contained a large quantity of blood. There were eight perforations in the lower end of the jejunum, and it was necessary to remove four feet of intestine. This was done, and a lateral anastomosis completed. The ureter was also injured. Patient made a complete and uninterrupted recovery.

**Case 23.**—Pte. McJ., Black Watch. This man was wounded in a bomb explosion, and there were at least five penetrating wounds of the abdomen. When admitted he was very collapsed, pulse being 150. Operation was delayed for some time, and then performed under ether anaesthesia. There was a great amount of effused blood. Tracing the small intestine, there were fourteen perforations in the lower end of the jejunum, and it was necessary to remove six feet of gut; a lateral anastomosis was completed. There were four perforations in the descending colon, and these were closed with suture; a single large perforation in the transverse colon was converted into a colostomy. The patient passed a comfortable night and was remarkably well throughout the following day. He died somewhat suddenly on the second morning after operation.

**Case 24.**—Pte. C. R., Seaforth Highlanders. There was a single entrance wound in the left buttock. It was interesting to note that there was no rigidity on palpation, but pain was complained of. Collapse was so intense that immediate operation was impossible; after some hours there was a slight improvement, and operation was then performed under ether. There was an enormous quantity of free blood in the peritoneal cavity; there were four large perforations of the lower end of the ileum, three of them tearing the gut completely across, in addition there were three extensive bruises of the gut and two tears in the mesentery which were bleeding profusely. Eighteen inches of small intestine were removed. The iliac colon was so damaged that it was necessary to perform an inguinal colostomy. The patient died of shock eight hours after operation.

The above cases are illustrative of the operation of resection and anastomosis of the intestine. In discussing the treatment of perforating wounds of the intestine, we mentioned the possibility of having in some cases to do a resection of intestine with the formation of a temporary enterostomy. It is an unsatisfactory operation, and, fortunately, we have had to resort to it in only one instance. That instance we now quote.
Case 24.—Pte. T. H., Black Watch. There was an entrance wound in the left buttock. The collapse was so intense that death ensued about one hour after admission. Examination showed eight perforations in the lower end of the ileum, two perforations in the
Penetrating Wounds of the Abdomen

lower end of the jejunum, and a complete severance of the iliac colon. There was a quantity of loose bone in the abdominal cavity.

Case 27.—Sapper H. J., Royal Engineers. This man was wounded with shrapnel, and there was a large entrance wound in the left flank. When admitted the patient was pulseless and unconscious, and he died one and a half hours after admission. Examination showed eight perforations in the lower end of the ileum, with extreme destruction of the gut.

RESULTS OF SMALL INTESTINE CASES.

<table>
<thead>
<tr>
<th>Total</th>
<th>Bullet wounds</th>
<th>Shell wounds</th>
<th>Bomb wounds</th>
<th>Suture</th>
<th>Resection</th>
<th>Enterotomy</th>
<th>Complicated cases</th>
<th>Recoveries</th>
<th>Died</th>
<th>Unoperated</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>17</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>13</td>
<td>1</td>
<td>10</td>
<td>7</td>
<td>12</td>
<td>2</td>
</tr>
</tbody>
</table>

* One case eventually succumbed to an ascending spinal meningitis.

WOUNDS OF COLON.

We have a series of twelve cases to record, but several of these have been already mentioned in dealing with stomach and small intestine injuries. The general remarks one would make are very similar to those we have already mentioned in relation to the small intestine, but there are several points which are more or less peculiar, and these will be dealt with.

Morbid Anatomy.

The effects of shell, bullet, or bomb vary exactly as they do in the small intestine. Very similarly also the damage appears to vary according to whether the colon is fixed or free; for example, the transverse colon and the free loop of the iliac colon are frequently torn entirely across, while in the more fixed points simple perforation is the rule.

Effusion from a wound of the colon has a liability to be shut off and localized, more especially when the wound occurs in the ascending or the descending colon; it is quite common to meet with a collection of fecal and semi-purulent matter entirely shut off and opening into the underlying colon (Case 28). It is, of course, an established fact that if the infection does not become localized the peritonitis from a large intestine wound is intensely virulent.

Clinical Features.—The clinical features are very similar
to those of the small intestine injury. They are, primarily at least, not so widespread, and early sickness as a rule is absent.

Treatment.—We have drawn attention to the liability which colon wounds have of becoming localized, and this fact has a bearing on the operative treatment which one employs. The bearing is, that if the patient comes under treatment at a period longer than twenty-four hours after the receipt of the injury it is a wise principle, primarily at least, to enlarge the original wound on the possibility that the infection is becoming localized. At an earlier period than twenty-four hours it is probably better to open the abdomen through a separate incision.

We have been impressed with the risk which one runs of overlooking injuries to the colon, and in one instance we have made this mistake (Case 35). The risk is greatest when the wound lies in one or other of the flexures of the gut.

The actual operative treatment may be summarized in two methods: (1) Simple suture; (2) simple suture with colotomy. The operation of resection may be left out of account; it is rarely advisable to practise it in this type of surgery. We have favoured the use of a colotomy in combination with the operation of suture; there is the obvious advantage that it increases the safety of the suture, while it obviates the passage of faecal matter through the damaged gut.

In wounds of the ascending and the descending colon we have been impressed with the advisability of draining the retrocolic space by a tube passing into the loin.

Case 28.—Serjt. B. A. The wound had been sustained with a fragment of shell about twenty-four hours previously; his general condition was good and local signs pointed to the fact that the injury and infection were limited to the neighbourhood of the wound. The original wound was opened up, exposing a small collection of faecal and semi-purulent matter; the containing cavity communicated with a wound in the ascending colon. The cavity was drained and a faecal fistula developed. Recovery.

Case 29.—Pte. B. W., King's Royal Rifles. The entrance and exit wounds were in the left loin; there were the signs of injury to the abdominal viscera, and a considerable degree of collapse. The abdomen was opened parallel to the left costal margin. There was a wound in outer side of the splenic flexure of the colon; the wound was closed with suture and drainage established in the flank. A faecal fistula developed on the fourth day. Recovery. In this case the stomach also was injured.
Penetrating Wounds of the Abdomen

Case 30.—Pte. O. H., Lincolns. This man was wounded with a fragment of shell. Opening the abdomen, in addition to wounds of the small intestine it was found that the transverse colon was divided at its centre. The transverse colon was brought out and so repaired that a single Paul’s colotomy tube was fastened into the gut lumen at the site of injury; a length of small intestine was resected. Recovery.

Case 31.—Rifleman P. F., Rifle Brigade. There were entrance and exit wounds in each loin respectively with complete abdominal rigidity; the general condition was good. The abdomen was opened in the middle line; there was a large quantity of free blood in the peritoneal cavity. Two large perforations were found in the ascending colon; a local colotomy and repair was done. The bullet in its course had passed through the spinal column, but without damaging the spinal cord. He remained well until 6 a.m. of the following morning, his pulse then suddenly failed and he died an hour later. Death was apparently due to peritonitis and shock.

Case 32.—Pte. S. J., North Staffords. The injuries were the result of shell wounds; there were three entrance wounds on the outer side of the hip. The patient was practically pulseless. Operation was delayed for two hours and restorative means were applied; operation was finally carried out under spinal anaesthesia. There was a large perforation of the iliac colon immediately above the loop; at a higher level the posterior wall of the descending colon was torn. Repair and colotomy were done. Death from shock ensued twelve hours later.

Case 33.—Cpl. H. J., Royal Irish Rifles. A bullet wound had been sustained twenty-four hours previously. There was a much greater degree of collapse than seemed compatible with the injury. The entrance wound was enlarged, the iliac colon was perforated in two places, there was no evidence of injury to other viscera. Repair and colotomy were performed. Throughout the first and second days following operation the patient steadily improved; on the third morning he was exceedingly well, when suddenly about midday he developed an extensive secondary hemorrhage. At this point the case passed out of our hands and we are unaware of his further history.

Case 34.—Pte. T. H., North Lancs. There were entrance and exit wounds in opposite loins; the exit wound admitted two fingers.

1 We have since heard that this patient died.
There were all the signs of injury to the abdominal viscera. On opening the abdominal cavity it was found to contain a large quantity of blood, there was a large wound of the postero-external surface of the hepatic flexure and there was also an extensive tuberculous peritonitis. With difficulty the wound in the colon was sutured. The patient died nine hours later. Post-mortem examination showed the presence of a generalized tuberculosis.

Case 35.—Pte. B. A., D.C.L.I. This patient was admitted suffering from a bayonet wound of the abdomen, the weapon having entered below the left costal margin. There were no evidences of abdominal infection, but the abdominal cavity was opened. No perforation was found, and there was neither free blood nor evidence of infection. The following day there was all the evidence of a general peritonitis; investigation showed that we had overlooked a small perforation below the splenic flexure. The patient later succumbed to peritonitis. This last case illustrates the liability of overlooking small wounds of the colon when they are situated in out-of-the-way places such as the hepatic and splenic flexures.

Case 36.—Pte. F. A., Worcesters. This patient was admitted suffering from a bullet wound of the left loin. Operation showed that the bullet had grazed the outer wall of the descending colon; it had not penetrated the mucous coat of the gut. The damage was repaired and local drainage was secured. On the second day after operation there was a suspicion of a fecal fistula, but this disappeared. Patient made a complete recovery.

Case 37.—Pte. M. H. W., R.W. Fusiliers. A fragment of common shell had passed through the left iliac fossa; the pelvis was fractured, and omentum was protruding from the wound. Operation showed that about one inch of the sigmoid flexure was entirely destroyed. A colotomy was performed and drainage secured. Patient made a good recovery.

Bullet| Shell| Bomb| Bayonet| Suture| Suture with colotomy| Complicated| Recovered| Died| Ultimate history untraced
--|---|---|---|---|---|---|---|---|---
4| 5| 2| 1| 6| 5| 4| 5| 6| 1†

* This total includes two cases of multiple perforation of the colon from bomb wounds; they were complicated with wounds of the small intestine, and they have been dealt with under that heading.
† We have since learnt that this patient died.

WOUNDS OF SPLEEN.

In two cases damage to the spleen rendered it necessary to perform the operation of splenectomy.
Penetrating Wounds of the Abdomen

Morbid Anatomy.

In one case a bullet was responsible for the damage; it had passed through one pole of the spleen, tearing it into two portions and splitting it in all directions. One portion of the spleen could not be recovered from the abdomen at operation, it appeared later from the wound as a small slough. In this instance the kidney was badly damaged (Case 38). The second case was of even greater interest than the first, because apparently the injury to the spleen was not a primary but a secondary result.

The bullet had passed comparatively superficially through the left flank, fracturing the lower ribs in its passage; the sharp fragments of ribs had been drawn inwards and these fragments were responsible for the damage to the spleen. The movement of the spleen with each respiration had increased the damage, until at the time of operation the organ was reduced to pulp. This is the second instance we have seen of this form of injury to the spleen; the first was not under our immediate care.

Clinical Features.—The first case was observed about six hours after the injury was sustained. The general condition was wonderfully good, pulse being only 88 per minute; there was some muscular rigidity along the left side of the abdomen, the abdominal cavity contained a quantity of free fluid, and the temperature was normal. These, together with the entrance and exit wounds, were the only clinical evidences. The second case was different, in so far as forty-eight hours had elapsed since the receipt of the injury; during that time hemorrhage had been continuous. When admitted the patient was pulseless, there were all the evidences of intense hemorrhage; the abdomen was distended, rigid, and contained a large amount of fluid.

Treatment.—In both cases we found it necessary to remove the damaged organ; the idea of suturing could not be entertained. We made use of an incision parallel to the costal margin, and no difficulty was encountered in removing the part. Drainage was secured in the flank, and a Keith’s tube was passed through a suprapubic opening into the pouch of Douglas. In the three cases which we have observed the injury to the spleen was complicated in two cases by damage to one of two other organs, the left kidney and the splenic flexures of the colon. It is advisable to take care during operation that these complicating injuries are not overlooked.
SYNOPSIS OF CASES.

Case 38.—Cpl. S. C., Royal Engineers. There was an entrance wound over the spinal column and an exit wound in the left loin, there was left abdominal rigidity and evidence of internal hæmorrhage. The abdominal cavity was opened, it was found to contain a large amount of blood. The spleen was shattered, its pedicle was ligatured, and the remains of the organ removed; the left kidney

FIG. 12 (to illustrate Case 38).—Injury to spleen caused by rifle bullet. The lower portion was entirely detached and could not be recovered by operation. It was, however, recovered later.
was so extensively damaged that its removal was also necessary. An uninterrupted recovery.

Case 39.—Pte. B. A., Grenadier Guards. This man was wounded in the lowest ribs, at the posterior axillary line, forty-eight hours before admission; the wound was produced by a rifle bullet. On admission the patient was pulseless, obviously suffering in-

tensely from hemorrhage; the abdomen was distended and rigid. Upon opening the abdomen its cavity was found to be full of blood, the spleen was disorganized into a mass of bleeding pulp, the lower
ribs were fractured and their sharp ends had been driven into the spleen. The spleen was removed and the sharp bone fragments excised. Drainage was established in the flank and suprapubically. This patient died on the seventh day after operation; he apparently succumbed from heart failure.

**RESULTS OF SPLEEN WOUNDS.**

<table>
<thead>
<tr>
<th>Total</th>
<th>Primary damage caused by bullet</th>
<th>Secondary damage by broken rib</th>
<th>Recoveries</th>
<th>Died</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**WOUNDS OF LIVER, GALL-BLADDER AND DUCTS.**

In discussing wounds of this region we shall bring a series of thirteen cases under review, but it must be understood that only a relatively small proportion of these required operation.

**Morbid Anatomy.**

Our knowledge of the morbid anatomy of these cases is based entirely on operative experience; we have had no post-mortem experience.

The close relationship of the right pleura and lung to the right lobe of the liver is responsible for the fact that a wound of the liver is very frequently accompanied by damage to the overlying lung or pleura. This fact is important as the latter condition is apt to be overlooked. We have seen a case in which the lung wound had been unnoticed until the degree of fluid in the right pleura actually endangered the patient’s life. It would appear to be unusual to have much destruction or disruption of the liver tissue; probably for this reason the occurrence of a post-traumatic jaundice is uncommon. There is generally an escape of blood into the peritoneal cavity, and occasionally it can be demonstrated in the retroperitoneal tissues.

We have only one instance to record of a wound of the ducts: a case in which the cystic duct was divided close to its entry into the gall-bladder. Duct wounds are so frequently accompanied by injury to large vessels that the result is generally fatal before they can be given surgical assistance.

**Clinical Features.**—The clinical features may be remarkably scanty. If the wound has involved the lung and pleura, the pulmonary signs frequently disguise the abdominal features. Generally there is pain over the liver and beneath the right
Penetrating Wounds of the Abdomen

The pulse, temperature, and more especially the respiration, are increased. There is usually some rigidity of the upper part of the abdominal wall; we have observed that the rigidity is increased and becomes more generalized when there is a considerable effusion of blood into the peritoneal cavity. By percussion an effusion can sometimes be demonstrated in the right iliac fossa. One would expect greater interference with the excretory function of the liver than is actually the case. On only one occasion have we seen a large effusion of bile into the peritoneal cavity (Case 44). Post-traumatic jaundice is exceptional, and when it occurs it generally indicates a septic change secondary to the wound. There is no alteration in the bile contents of the faces, and the urine is free from bile.

Treatment.—We have only operated on such cases as showed progressive haemorrhage, or which from the clinical features we suspected to be complicated by wounds of other viscera. In one instance we operated for a wound of the cystic duct (Case 40). In another instance a late operation was necessary on account of the accumulation of bile in the peritoneal cavity. We have employed a Kocher's paracostal incision, or the angled incision recommended by Mayo Robson; both incisions have given excellent access. The operation has generally been confined to investigation, plugging and drainage.

Synopsis of Cases.

It is unnecessary to give details regarding the cases which were not operated on.

Operated Cases.

Case 40.—Serjt.-Major P. W., Connaught Rangers. There was an entrance wound below the costal margin with an exit wound behind. There was general abdominal rigidity, an increasing area of dulness in the right flank, and evidences of general collapse. The abdomen was opened through an angled incision, it contained a quantity of blood and bile. The gall-bladder was collapsed, and the cystic duct was divided close to its entrance into the gall-bladder. No other injury could be found, beyond some scoring of the under surface of the liver. The divided duct was drained with a “dressed” rubber tube. For two days there was a profuse discharge of bile; after that date it diminished and disappeared. Two months after the patient was in perfect health.

Case 41.—Pte. G. A., Royal Field Artillery. This man was
wounded by a shrapnel bullet, immediately above the right costal margin. His condition on admission was good, but some hours after admission signs of general peritonitis developed. The abdomen was opened; it contained a quantity of blood, and the upper surface of the liver was torn. The wound in the liver was drained with a dressed rubber tube. Patient made an excellent recovery.

*Case 42.*—Rifleman R. J., Rifle Brigade. There were entrance and exit wounds below the right costal margin and in the right loin, with general abdominal rigidity. The abdomen was opened and found to contain a quantity of blood. The under surface of the liver was torn and fissured. Drainage was secured with a dressed rubber tube. An uneventful recovery.

*Case 43.*—Pte. J. J., King's Royal Rifles. There were entrance and exit wounds in the right axilla and over the right kidney; the entrance wound was small, but the exit wound was large and admitted three fingers. The bullet had penetrated the liver, opened the extreme lower limit of the pleura, and passed through the extreme outer edge of the kidney. The wound was drained. For two days there were evidences of a urinary fistula. The discharge then ceased and an uneventful recovery was made.

*Case 43A.*—Pte. D. A., East Lancs. There was a large entrance wound over the tenth rib, caused by a fragment of common shell. The wound was enlarged, neighbouring ribs being resected. The fragment had opened the pleural cavity, torn the diaphragm, passed through the right lobe of the liver, and was removed from the muscles of the posterior abdominal wall. It measured one and half inches by three-quarters of an inch. Efficient drainage was established and an uneventful recovery was made.

*Case 44.*—Cpl. C. H. W., Royal Berks. There was an entrance wound over the right scapula caused by a shrapnel bullet; the bullet could be felt beneath the skin over the right costal margin. The projectile had obviously traversed the liver, but there being no abdominal symptoms no operation was done. Two days later slight jaundice developed, and there was free fluid to be made out in the abdominal cavity. The following day the jaundice had deepened, and the amount of free fluid had increased; the abdomen was therefore opened. The abdominal cavity contained a large amount of free bile. Drainage was established, and the discharge eventually ceased.

Cases 45, 46, 47, 48, 49, 50, 51 and 52 were not operated on.
Penetrating Wounds of the Abdomen

<table>
<thead>
<tr>
<th>Total</th>
<th>Bullet wounds</th>
<th>Shell wounds</th>
<th>Shrapnel bullet wounds</th>
<th>Pure wounds of liver</th>
<th>Liver wounds complicated with pleural wounds</th>
<th>Duct wounds</th>
<th>Recovered</th>
<th>Died</th>
<th>Not operated on</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>13</td>
<td>—</td>
<td>7</td>
</tr>
</tbody>
</table>

WOUNDS OF KIDNEY AND URETER.

We have had three cases of wounds involving the kidney, and one case in which the ureter was damaged.

**Morbid Anatomy.**

In regard to the kidney wounds, in two cases the injury was comparatively slight, necessitating only a simple drainage. In the third case the kidney was so badly damaged that nephrectomy was necessary. But the apparent triviality of the kidney wound is sometimes no guide to the organic disintegration which occurs. Even in the slightest wounds the organ shows extensive microscopical changes of minute necrosis and hæmorrhage.

**Clinical Features.**—In each of our cases we got our first indication of the kidney being damaged from the position of the wound. One would reasonably expect hæmaturia to occur; blood was present in the urine in the two comparatively slight cases with which we had to deal; in the severe injury the remainder of the pelvis of the kidney was blocked with blood-clot, and there was no indication of hæmaturia.

**Treatment.**—Generally speaking there are three possible operative procedures which one may be called upon to perform: (1) Simple drainage; (2) suturing the kidney; (3) nephrectomy. We employed the first procedure in the two instances in which the damage was slight; a "dressed" tube was passed down to the kidney wound and gauze was loosely packed around it. This method gave every satisfaction. We have had no suitable case in which to employ the second procedure.

One case demanded the operation of nephrectomy (Case 55). In this instance the spleen was removed in addition to the kidney; the operation was carried out transperitoneally.

In the majority of instances the operation will be done through an anterior incision by reason of the fact that it is necessary to examine not only the kidney but also the general abdominal viscera.
SYNOPSIS OF CASES.

Case 53.—Pte. G. F., Rifle Brigade. Wounded by a bullet in the left loin; the projectile passed across the back without damaging the spine and emerged on the opposite side. The left posterior wound was enlarged. The descending colon had been stripped forwards from the kidney, and the projectile had grazed the outer border of the kidney. Drainage was secured, and patient made a good recovery.

Case 54.—Pte. J. J., King’s Royal Rifles. There was a small entrance wound in the right posterior axillary line; there was a large exit wound over the right kidney. The posterior wound was enlarged, and the eleventh and twelfth ribs were removed. The bullet had opened the pleura, damaged the liver, and passed through the outer edge of the kidney. Drainage was established; for two days there was a slight discharge of urine. Eventually recovery.

Case 55.—Cpl. S. C., Royal Engineers. There was an entrance wound over the spine and an exit wound in the left loin. There was left abdominal rigidity, and evidences of internal hemorrhage. The abdominal cavity was opened, and was found to contain a large amount of blood. The spleen was found to be shattered to pieces; it was removed. Palpating the left kidney, it likewise was found to be in pieces. The peritoneum to the outer side of the colon was divided and the gut separated inwards; the remains of the kidney were removed; drainage was established in the flank. Recovery.

WOUND OF URETER.

We have had a single instance of this injury and we offer no comment beyond briefly describing the case.

Case 56.—Pte. R. J. W., Irish Guards. He was shot at close range in the abdomen by a machine-gun bullet. On operation there were found to be eight perforations in the small intestine. In addition to blood, the abdominal cavity contained a quantity of urine; this was found to have escaped from a wound of the left ureter, where it passed into the pelvis. As the patient’s general condition was grave, no attempt was made to repair the ureter wound, but a drainage-tube was sutured in position, and drainage also established in the flank. In addition a resection of small intestine was perforated. After the second day there was no discharge of urine, and patient made an uneventful recovery.
Penetrating Wounds of the Abdomen

RESULTS OF KIDNEY AND URETER CASES.

<table>
<thead>
<tr>
<th>Total</th>
<th>Bullet wounds</th>
<th>Shell wounds</th>
<th>Drainage</th>
<th>Nephrectomy</th>
<th>Recoveries</th>
<th>Died</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4</td>
<td>—</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>—</td>
</tr>
</tbody>
</table>

WOUNDS OF BLADDER.

We have had the opportunity of dealing with four of these cases; three of them were examples of intraperitoneal rupture; the fourth was an example of an extraperitoneal wound.

Morbid Anatomy.

There were two facts which impressed themselves upon us. The first was that an intraperitoneal wound of the bladder is in nearly every instance complicated by wounds of other viscera, usually the rectum and small intestine. The second fact is illustrated by Case 59, in which a non-penetrating wound of the abdominal wall, sustained by a man with a full bladder, may produce a rupture of the bladder. Details of the cases are added.

Clinical Features.—The clinical features which are observed were complicated by the symptoms of other wounded viscera, except in one case (Case 59).

The features were those of a somewhat slowly developing general peritonitis, with at first local pain over the bladder and afterwards diffuse pain. In the intraperitoneal rupture the presence of free fluid in the abdomen could be demonstrated; in the extraperitoneal rupture there was a wound in the perineum, from which urine mixed with blood was escaping. In the uncomplicated case the degree of shock was less than in intestinal injury.

Treatment.—In the intraperitoneal rupture we adopted the operative procedure of a suprapubic cystotomy; in the extraperitoneal variety it was found to be sufficient to drain the bladder per urethram, while a local drain was established in the perineum.

SYNOPSIS OF CASES.

Case 57.—Pte. W. J., Black Watch. There was an entry wound immediately above the symphysis pubis; there was no exit wound. There were all the signs of extensive damage to the abdominal viscera, and shock was intense. Eight hours had elapsed since the injury. Operation showed a perforation of both walls of the bladder, five perforations in the lower end of the ileum, and a tear of the
large intestine at the junction of iliac colon and pubic colon. The bladder wounds were closed and a suprapubic cystotomy done; the colon wound was sutured and a colostomy performed above; a length of two feet of small intestine was resected. Patient died of collapse about ten hours after operation.

Case 58.—Pte. H. B., Manchester Regiment. This man was wounded by a revolver bullet above and slightly to the left of the symphysis pubis; there was no wound of exit. There were the usual evidences of injury to the abdominal viscera. Operation showed a perforation of the bladder on its left lateral aspect, eight perforations of small intestine and a perforation of the iliac colon. A suprapubic cystotomy was done, the small intestine was resected and the wound of the colon treated by suturing and colostomy. The patient succumbed on the following day.

Case 59.—Cpl. C. L., 20th Infantry Brigade (German). This case is of special interest because we believe it to be an example of the rupture of a full bladder secondary to a superficial non-penetrating wound of the abdominal wall. There were entrance and exit wounds immediately below the umbilicus. Examination showed that these wounds communicated and were not perforating. There were, however, distinct evidences of infection inside the abdomen. There was no other evidence of wound or contusion. The abdomen was opened; it contained a large quantity of urine. The bladder wall was split on its antero-lateral wall, and the wound was partly extraperitoneal, and partly intraperitoneal. A suprapubic cystotomy was performed and intra-abdominal drainage secured. Unfortunately a virulent peritonitis developed, from which the patient succumbed.

Case 60.—Lance-Cpl. F. J., Royal Engineers. This man while bending forwards was hit by a rifle bullet in the perineum; the projectile emerged above the crest of the ileum, of the left side. There was a considerable degree of collapse. The abdomen was rigid in its lower part; the patient had passed some blood-stained urine, and blood was escaping from the rectum. Operative measures were carried out under spinal anesthesia. The abdomen was opened in the middle line; there was a perforation of the mesentery of the iliac colon, the gut was not damaged. The bladder contained a quantity of dark-coloured fluid, urine mixed with blood, but there was no intraperitoneal perforation. The abdominal wall was closed. The patient was now placed in the lithotomy position. A full incision was made in the left side of the perineum and the wound opened up along the lateral aspect of the
rectum and bladder. Drainage-tubes were placed in position by the side of each organ. A large catheter was passed into the bladder per urethram; the bladder cavity was washed out and the catheter fixed in situ. The bullet in its progress had fractured the lateral wall of the pelvis. For two days the lateral bladder tube discharged freely; the discharge then ceased and the tube was removed. The urethral catheter was kept in position for five days. After fourteen days this man was discharged to the base.

**Results of Bladder Cases.**

<table>
<thead>
<tr>
<th>Total</th>
<th>Bullet wounds</th>
<th>Secondary rupture</th>
<th>Intraperitoneal</th>
<th>Extraperitoneal</th>
<th>Recovery</th>
<th>Died</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

**Wounds of the Rectum.**

Under this heading we only include those cases in which injury was sustained by that portion of the large intestine which extends from the level of the third sacral vertebra to the canal.

**Morbid Anatomy.**

We have experienced two cases representative of this type of injury. In both instances the wound had been sustained in the left buttock; the bullet had at first pierced the gut extraperitoneally, then emerging intraperitoneally it had produced further extensive damage in the small intestine. In both instances the lateral wall of the pelvis was fractured, and there was most profuse bleeding from the bone and the pelvic veins.

**Clinical Features.**—There were all the features which one associates with injury to the abdominal viscera, in addition recent haemorrhage was escaping from the rectum. As a rule in these cases there is retention of urine, and if urine is voided pain is complained of in the region of the bladder. We have had no means of judging the degree of shock, which such a wound by itself would produce, as both cases were complicated by extensive damage to the small intestine.

**Treatment.**—We at first proceeded to open the abdomen. The wound in the rectum was sutured, and an inguinal colostomy performed; any repair of small intestine which was necessary was carried out. In both instances we further attempted to drain the extraperitoneal wound of the rectum by enlarging the entrance wound and passing a tube to the damaged wall of the
gut. Both cases unfortunately ended fatally; the shock produced by the damage to small intestine was apparently the cause of death.

**Synopsis of Cases.**

**Case 61.**—Cpl. H. J., Seaforth Highlanders. There was an entrance wound of the left buttock, and in addition there were the signs of injury to the abdominal viscera. There was no exit wound; the entrance wound was bleeding profusely. The abdomen was opened; there was a relatively small wound in the right wall of the rectum; there were six perforations in the lower end of the ileum, and the abdominal cavity contained a large quantity of blood. The wound of the rectum was sutured, and a colostomy performed; the damaged loop of small intestine was resected; the entrance wound was opened up, and as far as possible an extra-peritoneal drainage of the rectum established.

**Case 62.**—Pte. S. W., Connaught Rangers. There was a small entrance wound immediately below the left buttock; great abdominal pain was complained of, and there was general abdominal rigidity. The abdominal cavity was opened; the right lateral wall of the rectum was perforated and there were several perforations in the lower end of the ileum. The rectal wound was closed with sutures, and an inguinal colostomy was done; the damaged portion of small intestine was resected.

**Results of Rectal Wounds.**

<table>
<thead>
<tr>
<th>Total</th>
<th>Bullet wounds</th>
<th>Simple wounds</th>
<th>Complicated wounds</th>
<th>Recoveries</th>
<th>Died</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
<td>—</td>
<td>2</td>
<td>—</td>
<td>2</td>
</tr>
</tbody>
</table>

**General Remarks.**

We are convinced that in the vast majority of cases of penetrating wounds of the abdomen operative measures offer the best chance of success. We would qualify the statement by excluding from the category uncomplicated wounds of the liver and certain wounds of the kidney. When the wound affects the hollow viscera of the abdomen, we are satisfied that it is only as the rarest exception that a spontaneous recovery occurs.

When these cases arrive in hospital they are almost universally in a state of intense collapse. We have therefore found it advisable to wait for a period of from one to two hours until the increased shock of the journey has subsided.
To this rule we make one exception; those cases which show evidences of rapid and progressive hemorrhage; in such cases the risks attendant on immediate operation are taken.

During the interval of waiting it is difficult to decide whether or not active stimulant measures should be adopted. These cases are generally complicated by some degree of hemorrhage, and stimulant measures in all probability tend to increase the bleeding; we therefore limit the pre-operative stimulation to getting the patient thoroughly warm and administering one cubic centimetre of pituitary extract.

During the operation every precaution is taken to minimize the degree of shock; the theatre is thoroughly heated, the table is provided with a hot-water bed; lately, we have found it advantageous to operate on these cases while they are in the Trendelenburg position.

Immediately before the operation commences the administration of subcutaneous saline by a Lane’s bag is begun and it is continued throughout the operation; three to four pints of fluid are frequently given in this way. We have tried several different methods of anaesthesia. We have had good results from the use of spinal anaesthesia, but there is difficulty in obtaining the freshly prepared anaesthetic, and it would appear that this is an important detail. In two instances we have had patients collapse suddenly after the administration of this anaesthetic. More lately, and on the suggestion of a paper by Yandell Henderson, we have employed closed ether anaesthesia. The paper above mentioned deduces evidence to show that by this method of anaesthesia shock is considerably lessened.

The method has given us great satisfaction. Briefly, the operative technique which we have employed is as follows:

The abdomen is opened in what would appear to be the most suitable situation and generally in the middle line. A large incision is employed. If the abdominal cavity contains a large quantity of blood, sufficient of this is rapidly swabbed away with a long roll of dry gauze to clear the view. A systematic examination of the various viscera is now carried out. We begin by picking up the cæcum and recognizing the ileo-cæcal junction; we work back rapidly along the whole length of small intestine, examining not only the gut but also its mesentery. The large intestine is reviewed, special attention being paid to the various flexures. If necessity arises the stomach on both aspects, the duodenum, the liver, and spleen are examined. It is a wise precaution to palpate both
kidneys, especially the left kidney, in cases of damage to the spleen. The pancreas is reviewed during the examination of the posterior wall of the stomach. The pelvic viscera are examined last, and to facilitate their examination the residual haemorrhage is more completely cleared away. The question arises whether or not the abdominal cavity should be washed out. In early cases with extensive soiling of the peritoneal cavity we have done so; in later cases and in those which showed evidences of peritonitis we have not done so. We have found it sufficient to establish drainage by a single Keith's tube, passing into the pouch of Douglas. In special instances, such as have already been mentioned, we have found it necessary to drain locally or in the flanks. We invariably close the abdominal wall with through-and-through sutures of silk-worm gut, guarded where they pass over the wound junction with small pieces of capillary rubber tubing. A Doyen's handled needle is the ideal instrument for inserting these sutures.

Throughout the operation, speed is an important factor, coupled with every possible avoidance of shock. As regards the post-operative treatment, there is very little which we wish to add; it is similar to that of every other abdominal operation. Special attention is paid to the administration of fluids; for choice by the administration of continuous rectal salines, and by subcutaneous infusions.

One is frequently asked regarding the prognosis of these cases. There is this fact to be recognized, that one must be prepared for repeated most bitter disappointments, but when one comes to view a series of cases the gains seem infinitely greater than the losses. The prognosis, of course, very largely depends on the degree of the injury sustained, but an even more important factor is the length of time which has elapsed since the injury was sustained. Early operation offers the best and surest chance of ultimate success. In reviewing the statistics of the results of such operations as these, it is impossible to consider the question en masse. Each individual case must be considered, for the chances of success depend upon so many factors that it varies enormously in different instances.

We wish to acknowledge our indebtedness to Colonel Cuthbert Wallace, for his encouragement and advice; also to Lieutenant-Colonel Wear, C.M.G., R.A.M.C.(T.), for permission to record these cases. The illustrations are the work of Serjeant Wilson and Private Warr, R.A.M.C.(T).