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ABDOMINAL WOUNDS IN WAR: TREATMENT OF INDIVIDUAL LESIONS*

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The wound of entry caused by a rifle bullet usually has a small more or less circular appearance. If inflicted at very short range, as in accidental or suicidal lesions, there may be much bruising and local trauma and a relatively large wound of exit. In such cases the blow of impact is very considerable and there is much shock. At an intermediate range there is less local trauma, but the patient is knocked out and brought to a complete stop at the time of wounding. Shock and collapse are still considerable, and are probably increased by internal haemorrhage. There is usually severe pain. At a long range the impact is much less, and it occasionally happens that in the excitement of the engagement the man may not even know that he has been injured. The velocity of the missile may be so diminished that there is no wound of exit, and in some cases it fails to enter the abdominal cavity but travels for a certain distance in the layers of the abdominal wall. In such cases the wound is relatively clean and sepsis is almost entirely dependent upon the presence of visceral injury. In the last two varieties any visceral wounds consist of small clean punctures which are more amenable to simple suture.

Lacerated and Bayonet Wounds

Injuries caused by fragments of H.E. shell are nearly always more disruptive, so that even a small fragment which makes a clean small wound of entry causes considerable laceration of the underlying muscle and irregular tears of the viscera. Such small fragments have a very high initial velocity, which, however, is soon lost against the resistance of the tissues, so that the fragment may not traverse the body but remains embedded within it. Larger masses having a much higher momentum will probably pass through the body and not only cause wide destruction of the viscera but form large jagged wounds of exit. All such fragments, being irregular, are much more prone to carry in pieces of clothing and sometimes even metallic and other bodies which have been present in the pockets. They are therefore, if not treated early, practically always followed by severe sepsis even if the gastro-intestinal tract is not injured.

Large lacerated wounds may occur from glancing blows by irregular missiles. Direct blows of this nature cause so much local injury and collapse that survival is as a rule short. Such lacerations may involve considerable destruction of the abdominal wall, either of all layers—in which case there is much prolapse with perhaps injury of the intestines—or of the cutaneous and muscular tissues only. In this and in past wars remarkable cases have been recorded of extensive prolapse of the intestines, in some of which the patient, supporting his intestines in his hand, has walked to aid and yet recovery has taken place. A satisfactory result will naturally depend upon the time at which treatment can be given. If seen at an aid post situated at a considerable distance

from a hospital or mobile team, the intestines should be washed and replaced, the wound dusted with sulphanilamide, a few stitches inserted, and the patient sent on to hospital. If surgical attention can be given very soon, a dressing should be applied and operation undertaken at the earliest opportunity. Under general anaesthesia the intestines should be wrapped in a sterile towel wrung out in saline, and the wound cleaned in the usual way, with excision of all dead and severely lacerated tissues. The intestine is then carefully examined and, if uninjured, freely washed in saline and replaced. The peritoneum is sutured completely or closed so far as is possible. If the muscle has been much injured the cavity is dusted with sulphanilamide and the wound lightly packed with paraffin gauze. Antitetanic and anti-gas-gangrene sera should be administered. If recovery takes place there is of course considerable risk of subsequent obstruction from intestinal adhesions, and a large ventral hernia is almost certain to occur.

Bayonet wounds differ but little from stab wounds seen in civilian life, although, being incurred in the full fury of a charge and with all the strength of a powerful man, they are severe in character and have a very high mortality rate. Solid and hollow viscera are almost certain to be cut. There is severe shock and rapid collapse from the severity of the haemorrhage. If the patient is in a sufficiently good condition to stand operation this will be performed at the earliest opportunity and will follow the general lines, the chief attention being given to suture of the internal injuries and less to the cleansing of the superficial wound, which, being clean-cut, is less prone to become infected.

Crush Injuries

Severe crushes usually follow explosions of bombs and H.E. shells. They may be due to a direct blow from a mass of material hurled by the explosion, but more commonly occur, both in the field of battle and in injuries to civilians in air raids, when the patient is buried in masses of falling earth or masonry. In such cases the injuries are often widespread. There may be fractures of several limbs, crushes of the chest with fractures of ribs and injury to the lungs, or associated head lesions: with such a diversity of lesions and with the patient in a condition of severe shock an accurate diagnosis may be very difficult and sometimes impossible until a certain amount of recovery has taken place. In this type of lesion rupture of the solid viscera is more common and hence intra- or extra-peritoneal haemorrhage is more frequent than the escape of gastric or intestinal contents, but this may occur, as may rupture of a distended bladder. The symptoms of haemorrhage have been discussed in the first lecture, and it is on their presence and on the steady deterioration of the patient that the decision to operate will be made. Unless the patient is going downhill, as shown by an increase in the pulse rate, abdominal pain and distension, and a marked anaemia, it will often be better to delay operation for a short period. In some cases the haemorrhage will cease, the fullness, mild rigidity, and tenderness of the abdomen become more localized, and later a firm well-defined mass be formed as the blood becomes encapsulated. It may become so sharply defined that it simulates a large abdominal neoplasm. Such changes are more likely

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to occur with extraperitoneal haemorrhage around a kidney. The swelling will gradually decrease, taking perhaps 4 to 5 weeks to disappear, but in the end the patient may recover completely, although until the blood is absorbed there is always the risk of its becoming infected and forming a large abscess, which may have to be opened. If the haemorrhage is persisting, or if complete absence of abdominal movement on respiration, increase of pain, the presence of definite rigidity, or evidence of free gas in the peritoneum suggest a perforation of a hollow viscus, the abdomen will have to be opened. Access will as a rule be best obtained by a paramedian incision.

Haemorrhage

Whether the abdomen be opened as a step in the treatment of a perforating wound or on the diagnosis of internal haemorrhage with a crush, its presence will be evident from the amount of blood in the peritoneum. Its source must be located as rapidly as possible. With a penetrating wound the course of the missile will be known either by the presence of a wound of exit or by the radiological examination. With a crush the site of internal injury may be indicated by bruising of the abdominal wall. If absent, the most common sites—liver, spleen, kidney, and mesenteric vessels—must be examined in turn.

The liver is one of the commonest viscera to be injured. It occupies a relatively large area and is of a soft consistency, so that it is easily ruptured. Irregular tears may run from the free margin into the substance and bleed very freely. Much has been written on the assumed difficulty of suturing this organ owing to its softness, and many suggestions have been put forward of methods to facilitate the closure. The use of decalcified plates, the suturing in of omentum, or plugging with gauze have all been advocated. In my experience none of these complicated methods are ever necessary. The wound can always be closed by the use of sutures, and since the blood pressure is low bleeding is controlled. It is true there is a tendency for the sutures to cut out, but this can be overcome by the use of thick catgut as a suture material and the use of mattress sutures. When a wide tear is present a long needle loaded with No. 6 catgut should be passed from in front backwards through the whole thickness of the liver on one side of the laceration, across the gap, and up the other side from behind forwards. On this same side it is passed back again from in front backwards about an inch down from its point of emergence, crosses the gap again, and returns on the first side from behind forwards. A large mattress suture is thus passed with one complete loop on one side of the tear and with the two ends ready to be tied as the other loop on the other side. Before tying these ends a second piece of thick catgut is laid under the loop, across the tear, and under the two ends to be tied; these two ends are now steadily tied and, having a wide bite of the whole thickness of the liver, will not readily cut out. The mattress suture, however, approximates the posterior edges but leaves the anterior gaping. The two ends of the second piece of catgut which passes under both loops are now tied; this tightens up the mattress suture and approximates the anterior edges. I have never known this suture cut out or fail to control the haemorrhage. For a large tear several such sutures may be required.

Perforating wounds made by a bullet or piece of H.E. shell can be closed by simple sutures, but in the latter case care must be taken to see that the piece of metal is not lodged in the liver. If so, it can usually be felt with a probe and extracted with long forceps. At times it may be impossible to extract, but its retention is always apt to be followed by abscess formation. The suture of a simple tear and the control of haemorrhage are unlikely to be followed by any complication.

The other most common source of haemorrhage is a rupture of the spleen. In many cases this organ has been torn after quite slight accidents. Patients have tripped over an uneven surface and, falling on the left side of the abdomen, have suffered from a severe internal haemorrhage due to an injury of this nature. In some cases there has been a curious delay between the injury and the onset of the symptoms of haemorrhage. The explanation of this is believed to be that the spleen pulp ruptures and forms a large haematoma under the relatively tough capsule, which gives way only after some hours

or days; free haemorrhage into the peritoneum then occurs. The site of the haemorrhage can usually be determined from the fact that the blood is seen to be passing down from the left upper quadrant, and the tear in the spleen can usually be felt. By hooking two fingers over the gland and round the pedicle it can usually be drawn forward and inspected; if fixed, as it frequently may be if the site of previous disease, the paramedian incision should be carried up to the xiphisternal notch and, if right-sided, the falciform ligament should be divided between ligatures. If access is still insufficient the surgeon should have no hesitation in cutting the left rectus across in an upper and outer direction; this T-shaped incision always gives a good view. No attempt should be made to suture the organ, as its substance is much too friable. Fortunately its loss is readily compensated and no ill effects follow its removal. Haemorrhage can be easily controlled by gripping the pedicle, dissecting the vein and artery free, and ligaturing them in turn. The vessels may sometimes divide before they reach the hilum, and thus several have to be tied. By ligaturing the vessels independently the risk of injuring or removing a portion of the tail of the pancreas is reduced to a minimum. After removal the pedicle and the bed of the spleen should always be carefully inspected to make sure that the haemorrhage is controlled and to ascertain that the left lobe of the diaphragm has not been lacerated or ruptured. If a tear be found in it, it should be closed with a few sutures. It is in this type of lesion that the insertion of one pint of sterile saline into the peritoneal cavity before its final closure will often be found beneficial, but it should only be used if the injury was a crush, and not with penetrating wounds.

The amount of haemorrhage with a ruptured kidney is very variable. If the cortex has alone been torn there may be only extensive retroperitoneal haemorrhage, causing pain and some rigidity and tenderness in the loin on one side of the abdomen. Sometimes there is no haematuria, the presence of which means that either the pelvis or one of the calices has been injured. In such a case it may be very extensive and may, indeed, cause the bladder to fill with clot and give rise to clot retention. The peritoneum over the front of the kidney may be torn or cut by a missile, in which case the blood will pass freely into the peritoneum and the loss may be much more extensive. In some of these cases the decision as to the need for operation may not be easy, but will be based upon the amount of bleeding, whether internal or external. Since there may be doubt as to the site of the haemorrhage and of the presence of other lesions, especially if there be a perforating wound, access is usually best obtained by an abdominal approach. If the bleeding is coming from a renal area and if there has been haematuria, the peritoneum over the kidney is divided on the outer side of the colon and the kidney itself turned forward. At times the wound may be sutured and the organ saved; at others a nephrectomy is necessary: generally speaking, the indications for nephrectomy are a tear or injury of the pelvis or main vessels. In such cases the artery, vein, and ureter should preferably be tied separately. If the cortex be alone injured it should be sutured with thick unchromicized catgut, which should be passed as simple sutures. Mattress sutures are not necessary, and should not be used as they may cause wide areas of necrosis.

Rarely with crushes and frequently with penetrating wounds a relatively large vessel in the mesentery or omentum may be injured and lead to severe haemorrhage into the peritoneum. If only partly divided the artery will continue to bleed freely and its ends will not retract, so that it will not usually be difficult to locate; when divided completely the ends may retract from view and, with the patient in a state of collapse and shock, bleeding may temporarily cease. The source of the haemorrhage may then be more easily overlooked, but the tear of the mesentery or omentum will be visible, and in all such lesions divided vessels should be looked for carefully and securely ligatured. With the division and ligature of vessels in the mesentery there is the risk that an adjacent loop of gut has been deprived of its essential blood supply. It must be carefully examined, and if its condition is dubious it must be excised, the resected area passing well beyond the doubtful segment. In cases of doubt a small cut may be made in the doubtful area, free bleeding indicating that the blood supply is satisfactory.

Perforation

Perforations of the hollow viscera may be of all sizes and shapes, and are often multiple: in crush injuries several loops may be caught in the compressing force and cut completely across or show bursting wounds. With penetrating wounds a bullet or piece of H.E. shell may pass through several coils of gut or through the stomach. With a rifle bullet fired from a distance the wounds are more commonly small round punctures through which the mucosa has prolapsed. If inflicted at close quarters or by a ragged piece of H.E. shell there are more commonly large irregular lacerations, and in some cases several inches of the gut may be absent or represented only by a narrow strip of the muscular coat. The amount of shock in these cases is considerable, but only a short time must be allocated to overcoming it; for the results of treatment for all perforations are, as is the case with a perforated ulcer, dependent upon the time at which operation is undertaken after infliction of the injury. For this reason the mortality among patients who have to be transported for a considerable distance is extremely high. When a penetrating wound is present the abdomen will be opened during the necessary exploration of the abdominal wound. Perforations or rupture following a crush injury are not as a rule difficult to diagnose. The pain is severe, respiratory movements of the abdomen are absent, and almost without exception there is a degree of abdominal rigidity far in excess of that which would be caused by a tender and bruised muscle. In some cases there is evidence of free gas in the peritoneum. Here, as in all cases in which there is no penetrating wound, access is best obtained by a paramedian incision. When the peritoneum is opened there will usually be an escape of free gas and a considerable quantity of fluid. In the majority, however, this does not contain visible gastric or intestinal contents. The muscular wall of the gut is so paralysed by the injury that only enough escapes to cause severe irritation and infection of the peritoneum. The fluid is of a slightly mucoid type containing flakes of lymph, which in the later stages rapidly becomes purulent. It is in these cases more than all others that a rapid comprehensive survey is so essential; for not only are the perforations so frequently multiple but there may be additional damage to the solid viscera or other structures. Care must always be taken to examine for the presence of retroperitoneal lesions, which are especially common with the duodenum.

A wound of the stomach will generally be in the neighbourhood of the greater curvature, and may consist of a round or irregular perforation passing through both walls; it is very necessary, if a wound be seen on the anterior surface, that the posterior wall be carefully examined. In other cases a notch may be cut out of the greater curvature. The area posterior to the stomach must also be examined, for the pancreas or other structures may also be injured. The gastric wounds can generally be easily sutured by two layers of continuous chromic gut, the first passing through all coats, and the second, acting as an embedding suture, passing through sero-muscular coats only.

Wounds of the small intestine may be small perforations through both walls, cuts through the mesenteric or anti-mesenteric borders, or larger and more destructive lacerations. If multiple they may be close together so that there are several wounds in a foot or less of the gut, or they may be more widely separated. Generally speaking, better results follow the suture of several perforations than a resection; therefore, whenever it is possible to close the opening and to leave viable gut with an unnnarrowed lumen, this method should be chosen. In order not to narrow the lumen the opening should of course always be sutured transversely to the long axis of the gut. When a portion of the intestine has been severely lacerated, when the mesentery has been severed or so injured that the blood supply has been destroyed, or in some cases where there are multiple wounds in a small area, resection may be necessary. After removing the injured segment widely enough to traverse normal tissue the surgeon may restore continuity by end-to-end suture or by closure of the ends and the performance of a lateral anastomosis. My own preference is always for end-to-end suture, as it can be rapidly performed and leaves no blind ends which might give subsequent trouble.

Injuries of the large gut are of the same general types as those of the small intestine, but the faecal contamination is more likely to be followed by serious infection of the peritoneum and wound. The wall of the large intestine is very thin, and, indeed, one is often struck with wonder, during an operation upon the colon, that an action of the bowels ever takes place; yet this thin-walled viscus is capable of the most powerful contractions. The highly infected contents, which may be solid or semisolid instead of fluid, the powerful muscular contractions, and the thin walls make an aseptic union much less certain than with injuries of the stomach or small intestine. For this reason many surgeons view an excision of a portion of the colon and end-to-end suture with trepidation.

Small wounds should be sutured, and the suture line may be reinforced by the application of near-by appendices epiploicae or a piece of omentum; but larger lacerations are often best treated by trimming up the edges and bringing the injured loop or the separate ends to the surface in the form of a temporary colostomy. Wounds of the lower pelvic colon or rectum should always be sutured, if possible, and an iliac colostomy usually performed above them. In most wounds of the colon the risk of infection is so increased that drainage with a rubber tube should be provided. If there has been a wound of entry or exit through the pelvis this must also be treated on general principles.

The fundus of the bladder may be wounded by penetration of bullets or pieces of H.E. shell if the viscus be distended, and when in a similar state it may be ruptured by a crush injury. Penetrating wounds through the pelvis may also injure the base of the bladder. With these injuries the presence of urine may be recognized in the peritoneum, or the nature of the lesion may have been diagnosed by the presence of haematuria or the inability of the patient to pass urine. Whenever possible wounds of the bladder should be sutured with catgut, but often it will be safer to drain the viscus with a suprapubic tube.

Abdomino-thoracic wounds present a serious problem. The treatment of these dangerous lesions has been admirably described in the comprehensive appendix on chest casualties by Mr. Tudor Edwards in the Emergency Medical Services instructions. He points out that it is essential to operate as soon as the patient is fit enough. These and all other war injuries of the abdomen are also fully discussed in the fascinating monograph *The Abdominal Injuries of Warfare*, by Gordon-Taylor.

If the missile has traversed the lower chest and the x-ray plate shows the piece of metal to be lying just below the diaphragm, so that it is certain that the lesions do not extend below the upper abdomen, it is best to deal with the injuries within the thorax as the first step, and then, by excising the wound in the diaphragm and perhaps enlarging it, to repair the visceral lesions within the abdomen, after which the diaphragm is carefully sutured. In many cases, however, the abdominal injury cannot be sufficiently explored by this method, so that after repair of the thoracic injury and the wound of the diaphragm a separate abdominal incision should be made. This is particularly true if the missile has passed downwards into the abdomen.

In some cases the thoracic wound may be of but slight importance but there is evidence of severe abdominal injury; the abdomen should then be opened as a primary measure. In yet others the wound may be at the level of the lower ribs in front, and access may be most readily obtained to both the abdominal and the thoracic cavities by cutting through the costal arch and, if necessary, the diaphragm.

This discussion has of necessity been brief, and I can only hope that I have given you a lead as to the methods you will find most useful. With a rush of casualties you will have to make quick decisions. Like all of us, you will make mistakes, but these will be reduced to a minimum by those who make one orderly investigation, arrive at a certain decision, and act rapidly upon it. Uncertainty and indecision are fatal errors.

L. H. Klinger and S. A. Blauner (*Amer. J. Dis. Child.*, 1942, 64, 462) record the occurrence of amaurotic family idiocy in identical twin girls. They have been unable to find a similar example in the literature.