WAR WOUNDS AND AIR RAID CASUALTIES

The following is one of a series of lectures on the Treatment of War Wounds and Air Raid Casualties recently delivered at the British Postgraduate Medical School

THE ABDOMINAL INJURIES OF WARFARE—II

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Wounds of Colon from Gunshot and High Explosive

The experience of a single operator may doubtless be capricious, but unfortunately my solicitude, which was awakened by all except the more simple forms of colonic wounds of gunshot origin, seems justified after perusal of the collected results of many surgeons published at the end of the war of 1914–18. In view of the increasing proportion of casualties due to high explosive there is little reason to think that the character of colonic injuries will be less severe or baleful in future campaigns. In the more frequent or typical examples of wounds of the large intestine, anatomical considerations played no small part in determining the serious character of the injuries.

(a) The frequent retroperitoneal situation of one or more of the wounds of this portion of the bowel increased yet did not condone its liability to be overlooked by the surgeon.

(b) The vulnerability of the retroperitoneal tissues to infection, more especially to anaerobic invasion, added to the gravity of gunshot wounds of the large bowel; the absence of a mesocolon in certain segments of the large gut, whereby the bowel and the lethal retrocolic and paracolic tissues were more closely juxtaposed, increased the potentialities of these vertical portions of the colon for threatening life in the event of wounding.

(c) Concomitant bruising of the large bowel was often considerable, and sometimes extended no small distance from the margin of the actual wound; this phenomenon was encountered much more frequently than in the case of the jejunum-ileum; surgical suture of the colon was thus rendered less secure and certain. The deposit of fat in the wall of the colon is always fraught with some surgical misgiving, and its existence demands watchfulness on the part of the operator; extravasated blood in the intestinal coats of the obese engenders a sense of still greater incertitude. Isolated bruised areas were often seen on the large bowel, and were not infrequently remote from the track of the missile. Such contusions varied in depth and surface extent, and were of some concern in view of their liability to lead to secondary perforation. Prophylaxis against this sequel demanded the most adequate provision for drainage.

(d) The outer coats of the large gut were sometimes ruptured and stripped back from the underlying intact mucosa; this phenomenon was occasionally discovered in close proximity to the track of the missile, and at other times might be remote from the actual perforation of the bowel. These injuries add to the anxieties of conservative surgery.

(e) The more fixed portions of the colon contrast with the small intestine in the matter of surgical accessibility, and the exposure of a retroperitoneal wound of the flexures or of the vertical segments of the colon through a mid-line incision might be associated with serious technical difficulties.

(f) The early escape of fluid faecal material from the lumen of the large bowel in cases of gunshot injury was more frequent than from the small gut, and its occurrence augmented the gravity of the prognosis: a peritoneum in-

undated with a flood of highly infective fluid from the intestine, the extraperitoneal tissues or psoas muscle soaked and sodden with escaping bowel contents, rendered efforts to save the patient fruitless and wasteful of time.

(g) Infarction was more often met with in the large bowel than in the small intestine in cases of gunshot wounds; such cases demanded drastic rather than conservative measures.

Method of Surgical Approach

I have always had a predilection for incisions made directly over the portion of the colon which demands surgical intervention; thus I have made frequent use of flank, iliac, or even subcostal incisions, in which the muscles of the parietes are divided in order to ensure adequate exposure of the field of operation. Such avenues of approach reduce to a minimum the anxieties of handling wayward small intestine, and the dangers of generalized contamination of the peritoneal cavity are thereby reduced.

In the case of "through-and-through" wounds of gunshot origin far out in the flank or iliac region, where any injury to the abdominal contents seems problematic, or where the outer border or posterior surface of the colon is the most likely site of visceral injury, a lateral incision may perhaps be profitably utilized; yet there can be no certainty about the anatomical disposition of the abdominal viscera, and it must be remembered that on the left side of the peritoneal cavity the descending and iliac portions of the colon are often overlapped by coils of the small gut. In most cases the surgeon will therefore be wise who primarily utilizes the mundane median or paramedian incision, so that he can assure himself beyond a doubt of the presence or absence or amount of damage within the belly. Should the position of a colon wound revealed by laparotomy render the injury inaccessible to surgical suture or to other treatment through a midline incision, or should provision for adequate drainage appear desirable or imperative, approach can then be made by a supplementary incision in the flank or at the periphery of the abdominal wall. If there chance to be wounds of entry or of exit in flank or iliac fossa or over some remote corner of the abdominal cavity, such may be carefully excised, enlarged, and converted into a more convenient avenue of surgical approach to the injured abdominal area.

In deciding in favour of the preliminary median or paramedian incision it must be remembered that in not more than 60 per cent. of the cases of injury to the large intestine is the colon the only segment of the alimentary canal involved. In 40 per cent. large-intestine injury is complicated by lesions of other hollow viscera. No risks must be taken therefore: the operator must make absolutely sure.

If preliminary laparotomy reveals no intraperitoneal injury, great care must be taken not to convert a small or uncomplicated extraperitoneal wound of the caecum or the vertical colon into one which implicates the general peritoneal cavity. Such smaller wounds may be trimmed and sutured from a posterior approach, provision being made through the muscle-cutting flank incision for drainage of the contaminated area.

Treatment

The treatment of gunshot wounds of the large intestine will, of course, vary with the anatomical and pathological character of each individual injury; the surgical measures adopted may also be dictated by other considerations, such as the coexistence of multiple injuries, concomitant haemorrhage, etc.

Small intraperitoneal wounds of the caecum and colon merely require suture, but in the case of this part of the bowel there is not the self-same confidence in the efficiency of a single suture that obtains in small-intestine injury, and most surgeons will employ a double layer of sutures. Greater confidence will be felt if a graft of omentum or an appendix epiploica can be utilized to reinforce the suture line. Most of the successful cases of gunshot injury of the large bowel are of this type.

The more frequent and typical gunshot injury of the colon has many or most of the characteristics that I have already described: most of the wounds are associated with greater contusion than obtains in the small bowel; infarction is more frequent, and the adjacent extraperitoneal tissues of the postero-lateral wall of the abdomen are the seat of a haematoma, certainly contaminated, perhaps already gravely infected with organisms which may have been introduced with the missile or may have been denizens of the lumen of the injured intestine. In some cases the wounds are large and gaping; they are rarely multiple, but the damage and tearing of the coats of the caecum or colon render local suture unpromising.

INDICATIONS FOR RESECTION

I therefore find myself in disagreement with those who deny a place for resection in the case of colon wounds. I am convinced that resection is the method of election—or, indeed, of necessity—in the following cases: (a) those whose caecum or colon is in a condition of infarction; (b) where there is extensive separation of the bowel from the mesocolon, especially if the latter is the site of a haematoma or is actively bleeding; (c) in cases where the vitality of the bowel is crushed out of existence by a large piece of metal or a fragment hurled with all the force of a high explosive; and (d) in some cases where the wound of the large intestine has been of such magnitude or difficulty of approach as to suggest the formation of an artificial anus. In the last-mentioned group recourse may well be had to resection, when the high mortality of the colon anus in the great war is borne in mind; the adoption of this procedure would of course be influenced by the general condition of the patient.

The wide removal of damaged bowel and of the adjacent devitalized retroperitoneal tissue which resection facilitates finds justification not only in being in accord with the ordinary treatment of gunshot wounds by excision of the damaged area, but also by the good results in certain personal cases in which this more drastic operation was undertaken. A temporary or prophylactic caecostomy proved of inestimable value in my hands in these large-intestine resections.

It is by no means remarkable that resection should have been discouraged in the case of gunshot wounds of the large bowel, for the approximation of healthy segments of colon after the removal of damaged gut is, in most parts of the large intestine, a far less simple surgical exercise than in the case of the closely approximated coils of jejunum-ileum, with their common mesentery: the sacrifice of considerable segments of sessile colon may be neces-

sary in order to secure a satisfactory end-to-end union of healthy, undamaged segments of large bowel without tension. Moreover, large-bowel resection is not without its dangers, even in the tranquil atmosphere of the surgery of every-day life.

In the less serious type of wound of caecum or colon suture is, of course, to be preferred to resection. Suture suffices admirably in this group of injury: such wounds are mostly of the nature of tears or perforations, and the bowel is rarely divided completely. Moreover, the absence of numerous loops and coils makes multiplicity of wounds uncommon, thus contrasting with their frequency when the small intestine is damaged.

Despite the risk of wearisome repetition, one cannot emphasize too strongly the extreme probability that a wound of the colon or rectum is of a perforated character, and it behoves the surgeon to satisfy himself as to the existence or absence of a retroperitoneal wound in addition to more obvious and accessible peritoneal injury of the large bowel. These retroperitoneal colonic injuries, with consequent infection of the extraperitoneal tissues, are much more likely to be fatal than intraperitoneal wounds. The term "colon septicaemia" was applied by Sir John Fraser to a group of symptoms indicative of an intensely rapid septicaemia which was met with in the case of wounds of the colon with a spreading infection to the retroperitoneal space; such were encountered especially in lesions of the more fixed portion of the large intestine where no mesentery was present. These wounds ran a sinister course partly because the tissues behind the coelomic cavity had not the powers possessed by the omentum and the peritoneum of dealing with organisms, especially anaerobes; partly because the retroperitoneal space, when infiltrated with blood, provided an ideal pabulum for the growth of infection, since injuries of this part of the bowel were difficult of exposure and access and held suture badly; and partly because there was difficulty in some cases in establishing drainage, especially in injuries of the rectum.

As a means of preventing fatal infection of the retroperitoneal space *colostomy sometimes proved valuable*, but this operation must be performed at a very early period before infection actually obtains hold of the vulnerable tissues behind the peritoneum, and reliance must never be placed upon its performance alone as an alternative measure to the establishment of free and adequate local drainage.

Attention may be appropriately directed here to the gangrenous ulceration of the mucous membrane of the more fixed parts of the large bowel to which Hamilton Drummond and Shaw Dunn first drew attention. This very rapid gangrene of the mucous membrane seems to be caused by the deprivation of its blood supply through the rupture of the small vessels and laceration of the underlying muscular coat of the bowel produced by a missile, the actual track of which may be some distance from the intestine. In these bursting or traction injuries the gangrene of the bowel leads almost at once to a severe infection of the retroperitoneal space. Colostomy can be of no more service in this class of case than the performance of an enterostomy in the treatment of a gangrenous appendicitis.

It is in such wounds that heroic measures must be employed to freely explore, drain, and possibly excise the damaged area of the bowel. Portions of the innominate bone or the coccyx may require removal to effect a thorough exposure of the rectum and the post-rectal tissues.

Wounds of Stomach and Urinary Bladder

Gunshot wounds of the stomach vary greatly in size and appearance, and usually involve both surfaces of the viscus. Suture will be employed as a rule, but the incidence of secondary haemorrhage during convalescence, often of fatal nature, raises the question of the desirability of excision of the damaged portion of stomach wall, when this is in an accessible position and the general condition of the patient does not negative such a step. In certain cases distortion, or uncertainty as to reliable closure of wounds of the pylorus, may suggest a supplementary gastro-enterostomy.

Gunshot wounds of the urinary bladder may be intraperitoneal or extraperitoneal; both surfaces of the bladder may be implicated. This last-mentioned form of lesion is common in buttock wounds, and may be complicated by a fractured pelvis and injury to the intestine. Suture of intraperitoneal wounds is easy; extraperitoneal wounds should be sutured where possible; and a corrugated rubber drain may be inserted if uncertainty be felt as to the security of the suture. In some cases a self-retaining suprapubic catheter may be used with advantage.

Penetrating Wounds of the Solid Viscera

The Liver.—The dimensions of the missile play no inconsiderable part in determining the type of hepatic lesion, which may take the form of a perforation, possibly with cracks and fissures radiating therefrom, a superficial "score," a ragged wound, or a crateriform cavity. The liver is damaged in practically every abdomino-thoracic wound on the right side of the body, and may be badly shattered in such injuries as the "stove-in" chest. The whole organ may be disrupted even by a bullet wound, and as much as one-third of the right lobe has been found loose in the peritoneal cavity. Examination of museum specimens illustrating gunshot injuries of the liver reveals lesions for which surgery is futile. It would be impossible to prevent infection by surgical measures throughout a long ragged track running from one lateral surface to the extreme pole on the other side of the body (Fig. 2),

FIG. 2.—Penetrating wound, traversing liver from right lateral surface to left border; the impossibility of mechanical excision and disinfection of such a track is obvious. (War Collection, R.C.S., 966.)

and surgical zeal would be entirely misplaced and probably harmful. The escape of important structures in the portal fissure and in the liver substance is sometimes remarkable, and the fatal ending is often due to damage to other structures.

I cannot agree with certain German writers who state that "the opening of the abdominal cavity is indicated not only in every certain case of liver injury, but also when such an injury is merely probable." If injury to other viscera can be excluded, abstention is the best policy except under the following conditions: (a) gross haemorrhage; (b) retention of a large missile in an acces-

sible position; (c) the probable association of some other abdominal or thoracic lesion which demands exploration. In many cases of liver injury there were few arresting clinical signs, and it is significant that in the abdominal cases which recovered without operation the wounds mostly lay in the liver area. Increasing confidence in the sulphonamide preparations, especially M & B 693, should diminish the incidence of sepsis in these tracks across the liver; and if only pathologists could control the anaerobic infections there would be no thought of surgical intervention for hepatic injury, except under the conditions just mentioned. The danger of bleeding from the liver depends mainly on whether large veins have been breached; if no big vein has been damaged haemorrhage ceases spontaneously. There is usually little oozing of bile, unless main ducts are severed. Collections of bile in the peritoneum and pelvis may occur later, demanding drainage.

Early jaundice may be slight and evanescent, and has no serious portent; the stools remain of normal colour. Later icterus has a much graver significance, and indicates serious infection; it is probably haemolytic in origin. Secondary hepatic haemorrhage is almost invariably fatal, and is usually associated with signs of sepsis, such as pain, elevation of temperature and pulse rate, abdominal distension, pallor, restlessness, and loss of strength. Sometimes a hepatic abscess may develop round a retained fragment of shell or bomb, and may prove fatal if not dealt with by adequate surgical methods.

The Spleen may be injured alone or in conjunction with other abdominal viscera; it is especially liable to damage in left-sided abdomino-thoracic lesions. Every kind of lesion may be produced, and life may be jeopardized by reason of severe intra-abdominal haemorrhage. It has been affirmed that the association of gastric and splenic injury is a fatal one, but this has not been my experience. It has already been advised that splenectomy should not be resorted to light-heartedly, but in my opinion this operation has not greatly increased the risk. The spleen may be exposed and dealt with through a paramedian incision, a Perthes incision, or by an abdomino-thoracic approach in injuries invading both cavities of the body.

The Pancreas.—Penetrating wounds of the pancreas were less frequent in the war of 1914–18, or at any rate less often recognized, than injuries of any other of the abdominal viscera. The intimate anatomical relations of the gland to the large blood vessels are such that a wound of the pancreas involves the greatest risk of an immediate severe and probably fatal haemorrhage. Many wounds of the pancreas doubtless never reached an abdominal hospital, and in such patients as survived to reach an operating theatre the lesion may have been overlooked by surgeons more intent on dealing with injuries of the hollow viscera, or the cases were designated "retro-peritoneal haematomata." Successfully treated cases of gunshot injury to the pancreas were certainly recorded by Richard Charles (two), Lockwood, Saint, Mayo-Robson (two), John Morley, myself (three), and others.

Abdomino-thoracic Injuries

Increasing familiarity with the problems of the surgery of warfare, and especially the radical treatment of the more severe injuries of the thorax, for which British surgery is under a special debt to George Gask, gradually led to a diminution in the mortality from these wounds as the years of the great war went by. In 1916 only 18 per cent. of these cases were saved, but in November, 1917, Sir Anthony Bowlby was able to report a recovery

rate of 49 per cent. In the autumn of 1918 I collected the results of 207 operations for abdomino-thoracic injury performed by six surgeons in the Fourth British Army (Jack Anderson, Saint, Stanley, Walker, Hancock, Gordon-Taylor), when the recovery rate reached 66.6 per cent., and in the case of Saint of Capetown and the late Jack Anderson was no less than 80 per cent. The individual results depend very largely upon the involvement of hollow or solid abdominal organs in the complicated injury; the latter type of wound produces a much lower mortality rate, but even in the case of hollow viscus involvement I had a 50 per cent. rate of recovery.

The treatment of abdomino-thoracic injuries may be outlined as follows:

(a) Where there is a through-and-through abdomino-thoracic wound on the right side, inflicted by only a small fragment, no active surgical treatment may be required.

(b) Where there is an abdomino-thoracic wound on the right side, and a small fragment is retained in an inaccessible position in the liver, an expectant line of treatment is the correct procedure.

(c) Where there is a small wound in the thorax, and there is evidence of abdominal injury demanding operation, the belly has priority in the matter of surgery, and should be approached by median, paramedian, or some appropriately placed incision. The thorax may require no special attention.

(d) Where there is a through-and-through wound involving thorax, diaphragm, and abdomen, and associated with severe injury to the thorax, the thoracic wound should be dealt with first, and an approach to the upper abdomen made through the diaphragm.

(e) Where there is a wound of entry in the thorax, inflicted by a large- or moderate-sized fragment of missile, which is retained, a radiograph is most valuable. The thoracic injury should again be dealt with first, and the abdomen approached through the diaphragm.

(f) In some cases, where the wound of the thorax is low down, access to supra- and infra-diaphragmatic areas may be obtained by cutting through the costal arch after the manner of Bland-Sutton, Duval, Kirschner, etc.

Injuries without Penetrating Wound

Injuries of the abdominal viscera may occur without penetrating wound. The demolition of buildings by air bombardment, with bricks, mortar, iron, and timber confusedly hurled by explosive force against the abdominal wall, may rupture intestine or rend the liver without any breach of the skin. Severe damage to the contents of the coelom may even be produced by mere explosive force without any impact of debris on the abdominal parietes.

In the surgery of everyday life it is affirmed that severe contusions of the abdominal wall are not often associated with internal injuries: the blow that expends itself in disrupting the muscular layers of the parietes is said to be too far spent to exert its baleful action on the digestive tube or the solid abdominal organs. No reliance is to be placed on such probabilities or possibilities in the damage inflicted by high explosives. I have no intention of enumerating all the signs and symptoms which point to damaged intestine in contusions of the abdomen; the late W. H. Battle, Sir James Berry, and Zachary Cope have all made signal contributions to our knowledge of this subject. Perhaps the most cogent reason for laparotomy in these cases of suspected gut injury is doubt; and where any uncertainty exists the surgeon should open the abdomen at the earliest moment. When unmistakable signs of peritonitis manifest themselves the golden oppor-

tunity has been lost: the patient is already doomed, and operation is only an agonal necropsy.

The surgical diagnosis and treatment of haemorrhage from the solid abdominal viscera are well known to all operators. An adequate exposure of the convexity of the liver in order to deal with liver bleeding may be impossible through the usual median incision. The removal of the cartilage of the costal outlet may be drastic, but emergency may demand the heroic; the adoption of this procedure has certainly been successful on rare occasions in my hands. Temporary control of the bleeding by compression of the structures in the free edge of the gastro-hepatic omentum has been stressed by Hogarth Pringle and Grey Turner.

Laparotomy Incisions and Drainage

Drainage of the Abdominal Cavity.—Where any doubt exists as to the propriety of drainage it is better not to drain. Drainage tracks are prone to become secondarily infected with streptococci on the lines of communication, sometimes with disastrous results.

Closure of the Abdominal Wound.—"Through-and-through" sutures save time, but should be used only on exceptional occasions: a carefully closed peritoneum affords some protection against the spread of infection from the abdominal wall to the coelomic cavity. In cases where large masses of the rectus abdominis or the lateral muscles of the abdomen require incision because of infection or threatened infection with gas gangrene, the space resulting may be temporarily filled with gauze soaked in some antiseptic such as eusol, flavine, etc., which is left in place under the sutured skin and removed only when it is felt certain that the parietal peritoneum is securely healed. A temporary buffer is thus provided between the intestines and the outside world!

DOCTORS IN TIME OF WAR

SCALES OF PAY FOR A NATIONAL EMERGENCY MEDICAL SERVICE

The terms of service under which doctors will be employed on emergency work in time of war are defined in a scheme which has been agreed between the Minister of Health, the Secretary of State for Scotland, and the Central Emergency Committee of the British Medical Association, as representing the medical profession.

The scheme provides for a national hospital medical service for the treatment of casualties, the service being organized and administered directly by the Ministry of Health and the Department of Health for Scotland. Doctors joining the service will assume for a period of three years a definite liability to serve in an emergency.

Method of Recruitment

The service will be recruited from medical practitioners other than those already in the regular whole-time employment of the Government or the local authorities. The British Medical Association is assisting in its recruitment, and doctors wishing to join should notify the Association, through their local Branch or Division, and not the Ministry or Department of Health. There will be two classes of service:

Class A.—Practitioners in this class will, in an emergency, be called up for whole-time hospital service with a liability to temporary transfer to any part of the country. Those required at the outset will be called up immediately an emergency arises; others will be called up at later