Wounds of the Abdomen and Pelvis

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WOUNDS of the abdominal viscera may occur with or without penetration of the abdominal wall by the wounding agent. Penetrating wounds may be caused by any missile from small bird shot to large shell fragments, or by any object from an ice pick or penknife to a two-by-four or highway guard rail. Nonpenetrating injuries may occur from blunt force ranging from bumping into a piece of furniture or blow of the fist to severe crushing injuries, falls, or blast injuries, particularly the underwater type. The stomach, rectum, and urinary tract may be damaged by diagnostic instrumentation, or any organ may be injured during surgical operation. Impalement by accidental or intentional approach through the anal canal may perforate the rectum. Fractures of the bony pelvis may be accompanied by injuries to the soft parts of the pelvis, particularly the bladder and urethra. Urethral damage may occur from impact in the perineum. Lacerations of the external genitalia occur from many causes.

Deaths following wounds of the trunk below the diaphragm are due predominantly to shock, hemorrhage, or peritoneal or extraperitoneal inflammation. Hemorrhage occurs from injury to major blood vessels or from the parenchyma of large solid viscera such as the liver, spleen, or kidneys. Shock is common with extensive wounds of the abdominal wall, as from close range shotgun wounds or massive soiling of the peritoneum. Inflammation may be bacterial, principally from leakage from hollow viscera, or chemical, due to leakage of bile, pancreatic juice, or urine. In the latter instances, bacterial infection is usually superimposed. Proportionately, nonpenetrating injuries are more likely to manifest hemorrhage from solid viscera rather than perforations of the gastrointestinal tract. However, both solid and hollow visceral injuries do occur in both penetrating and nonpenetrating wounds. Injuries from missiles follow in general the rules of wound ballistics—that is, very high velocity missiles may have small wounds of entrance, larger wounds of exit, and a disproportionately greater internal disruptive effect than do low velocity missiles. In lacerations of the gastrointestinal tract, eversion of the mucosa prevents spontaneous sealing of the wound and contributes to continuous leakage.

Due to fixation of the small bowel at its upper and lower ends, nonpenetrating wounds may cause

tears in the bowel and its mesentery near the ileocecal junction, the duodenojejunal junction, or in the duodenum. Similar shearing forces may exist in the urethra in the neighborhood of the triangular ligament.

In civilian practice particularly, the female may be the victim. Injuries may occur not only to normal female organs but to the pregnant uterus or to pelvic tumors. Many civilian patients have pre-existing diseases such as cardiovascular conditions, diabetes and alcoholism which require consideration.

DIAGNOSIS

Penetrating Wounds. The diagnosis of penetrating injury of the abdomen is usually easy and often self-evident. The greatest difficulty lies in small wounds inflicted by such things as pocketknives, ice picks, or bird shot, and in those instances in which the wound of entrance may be outside the abdominal area. Abdominal injury should be suspected in wounds of the thorax and in wounds of the thighs, perineum, and buttocks, especially if there is no wound of exit. In this respect, knowledge of the position of the patient in relation to the direction of the projectile at the time of wounding may be valuable. Information about the type of projectile and the range may be of assistance.

Preliminary examination of the patient should be directed first toward the presence and significance of associated wounds and the presence or absence of shock. If shock is present, treatment should be started without delay while further diagnostic procedures are carried out. Even if shock is absent, if the obvious character of the wound indicates that it is impending, measures should be

taken to combat it. In most instances, this means primarily the replacement of blood and the maintenance of circulating blood volume.

The next step is careful inspection of the wound to determine as closely as possible its extent and direction. Direction may often be estimated by carefully spreading the wound to see whether the deeper tissues are penetrated vertically or obliquely to the skin. In oblique bullet wounds, abrasion of the skin on one side of the wound of entrance and contusion beneath the skin on the other side may give an idea of the angle of penetration. Gentle palpation of the abdomen may disclose areas of rigidity and tenderness, and percussion may indicate the presence of gas in the peritoneal cavity, particularly over the liver, or of fluid in the flanks. Auscultation will usually reveal absence of peristalsis.

Observation of blood in the vomitus, if vomiting occurs, is, of course, of significance, as is the presence of blood on the rectal examining finger. A catheter should be placed in the bladder to determine the presence or absence of blood, and should remain as a valuable adjunct to postoperative care.

In the case of a retained missile, x-ray of the abdomen will give an idea as to the missile track.

If the diagnosis of penetration of the peritoneal cavity is still not evident, the wound of entrance should be excised down to the peritoneum, with all preparation for extensive laparotomy. Under no circumstance should such a wound be probed.

Nonpenetrating wounds. In contrast to penetrating wounds, the diagnosis of nonpenetrating wounds of the abdominal viscera may tax the abilities of the most experienced clinician. A good history of the injury is of extreme importance, but may be lacking in cases of alcoholism, shock, unconsciousness, or delayed rupture of solid or hollow viscera. The physical signs are internal hemorrhage and peritoneal irritation. Contusions and abrasions of the abdominal wall are of significance. Fractures of the lower third of the thoracic cage often are accompanied by subdiaphragmatic injury. Pain referred to the shoulder area may indicate lesions below the diaphragm. Percussion of the abdomen may disclose the presence of free gas or fluid. Tympany over the liver and dullness in the flanks are of importance. Peristalsis will usually be absent. Abdominal distention and localized tenderness becoming generalized may occur. Para-

doxical respiratory motion of the abdomen may be present in rupture of the diaphragm, as may be peristaltic sounds in the left chest. The presence of blood in vomitus, stool, or urine is, of course, important. Aspiration of the peritoneal cavity with a blunt 18 gauge needle is a valuable diagnostic procedure when positive for blood or gastrointestinal content. Negative aspiration does not, however, rule out visceral damage. Careful and repeated observation for hemorrhagic shock should, of course, be carried out.

Radiological examination may disclose the presence of free air, fluid, immobility of the diaphragm on the affected side, displacement of hollow viscera, particularly the stomach in case of rupture of the spleen, or obliteration of the kidney and psoas shadows in retroperitoneal hemorrhage. In the case of rupture of the diaphragm there will be fluid and perhaps abdominal viscera visualized above the diaphragm. Retroperitoneal emphysema may be present in injuries of the duodenum or of the extraperitoneal rectum. Negative x-ray examination does not rule out damage. In case of doubt, exploratory laparotomy is indicated and is safer than delay.

In some instances, evidences of intraperitoneal injury may not be apparent for many hours or even days after the injury. In rupture of the small bowel with minimal hemorrhage and soiling, the onset of bacterial peritonitis may be the first apparent clinical sign. This likewise occurs with injuries to the mesenteric blood vessels where signs of necrosis of the bowel may not occur for several days, and may manifest itself first by ileus. Delayed rupture of the spleen is common and may occur as late as two or three weeks following injury. It is usually due either to early plugging of the splenic wound by omentum with late autolysis or to subcapsular hemorrhage which may not be evident for several days until the capsule suddenly ruptures from internal pressure. These late cases may exhibit fluid in one or both pleural cavities due to reaction about the diaphragm. Repeated examination is essential in all cases of suspected nonpenetrating injury.

INDICATIONS FOR OPERATION

The diagnosis of intraperitoneal injury is an urgent indication for laparotomy, and should take first priority except in immediately life-endangering injuries to other parts of the body, such as severe cardiorespiratory trauma. When it is impossible to establish a positive diagnosis, but visceral injury cannot be ruled out and the patient is not

improving, exploration is indicated. When in doubt, to look and see is safer than to wait and see. Time consuming efforts at differential diagnosis of specific organ injury are not only futile but may be harmful. An exception is nonpenetrating kidney damage with easily reversible shock.

Once the diagnosis and decision to operate have been made, there should be minimal delay for resuscitation measures except in those instances when from the history and examination we are certain that intra-abdominal hemorrhage is not an important factor. In most early cases resuscitation measures, including blood transfusions, should be carried on concurrently with the most expeditious diagnostic and treatment procedures, since many of these patients are losing blood faster than it can be provided by transfusion. An indwelling urethral catheter and nasogastric tube should be inserted before operation, and both the stomach and bladder emptied.

General endotracheal anesthesia is preferred in most cases, both to give the safest relaxation and to prevent aspiration of gastric contents.

OPERATIVE TREATMENT

Incision. Since wounds of the abdomen require thorough abdominal exploration, the incision should be one which may be extended to any portion of the abdomen. A midline vertical incision is the most useful and may be extended upward, downward, or laterally as necessary. It may be made more rapidly than most other incisions, and closure is not only rapid but strong. If the lesion is definitely known to be confined to one quadrant of the abdomen, any incision—vertical, transverse, or oblique—of the surgeon's fancy may be used, provided that it allows adequate extension to expose unforeseen injuries. Upon first opening the peritoneal cavity, liquid blood should be removed by suction. Clots, if adherent, should be left in place initially as they indicate the site of tissue damage, and their early removal may cause recurrence of brisk bleeding and impede exploration. After liquid blood and detached clots have been removed, active bleeding points should be searched for and controlled at least temporarily. If the liver or spleen has been injured, bleeding and clots will be evident in the locality.

Spleen. If the spleen has been injured, splenectomy is the only treatment, even for small lacerations and contusions.

Liver. Most wounds of the liver may be treated conservatively, with hemorrhage controlled by pressure, gelfoam, or oxycel. Omentum is frequently useful in this respect. Detached or devitalized portions of liver should be removed. Foreign bodies, unless very small, should be removed from the liver to avoid later serious complications. Hemorrhage may be controlled tem-

The Orator And the Chairman

Dr. R. Arnold Griswold, Louisville (left) *made the Oration on Trauma entitled "Wounds of the Abdomen and Pelvis" at the Clinical Congress in Atlantic City in 1959. He was presented on that occasion by the chairman of the Committee on Trauma, Dr. Harrison L. McLaughlin* (right) *of New York.*

porarily by manual or tourniquet compression of the liver, or temporary pressure to the hepatic vessels by a finger in the foramen of Winslow and thumb on top. Fifteen minutes of the latter occlusion should be the limit. Temporary gauze packing is advantageous, but should be removed before closure. Control of large individual vessels in the liver should be carried out by transfixion suture of the vessel wall proper. Control of lacerations and fractures by interrupted large mattress sutures such as #1 chromic catgut on large atraumatic needles passed at least an inch back from the wound edges may be necessary for the control of severe hemorrhage. This method is, however, followed by increased slough of devitalized liver tissue.

External drainage, preferably through the right flank, should be carried out in all wounds of the liver to remove bile, blood, and the products of tissue damage. Drains should be placed in the liver tissue proper if there are deep tears or wounds. Additional drains should be placed in the subhepatic and subphrenic spaces. Wound closure about hemostatic gauze packs should be abandoned, since packs do not function as brains and since liver sepsis and serious hemorrhage almost uniformly follow their removal. If there is a concommitant wound of the diaphragm, it should be closed tightly to prevent leakage of bile into the thorax.

Bile Ducts. Injury to the cystic duct and gallbladder is treated by cholecystectomy or, on occasion, by cholecystostomy through the gallbladder wound if it is single. Injuries of the major bile ducts should, if possible, be sutured over a T-tube as a splint, with the T-tube emerging from the duct at a distance from the wound. If closure is impossible and the patient's condition warrants, anastomosis of the gallbladder with a hollow viscus and double ligation of the injured common duct below the junction of the cystic duct may be considered. T-tube drainage with definitive surgery at a later date is often the only safe alternative.

Pancreas. All wounds of the pancreas with the exception of minor contusion should be drained after controlling hemorrhage. In severe wounds of the body and tail, with transection of main ducts, distal partial pancreatectomy with splenectomy may be necessary.

Kidneys. In damage to the kidneys, nephrectomy

should be carried out only rarely, as in the case of complete fragmentation of the kidney, disruption of the blood supply, or uncontrollable hemorrhage, and not until presence of the opposite kidney has been verified. After control of hemorrhage and suture of the parenchyma, wounds of the kidney should be drained extraperitoneally through the flank.

Gastrointestinal Tract. After obvious hemorrhage has been controlled, systematic exploration of the gastrointestinal tract should be carried out from end to end, and wounds of the viscera repaired as they are found, or marked and closed with Allis or Babcock forceps until exploration has been completed. To prevent constriction of the lumen, perforations of the bowel are sutured in a transverse direction, preferably with two layers of interrupted fine nonabsorbable suture or two layers of continuous or interrupted fine catgut on atraumatic needles, to insure approximation of serosa to serosa in undamaged bowel. When multiple wounds of the small intestine are close together, or when the blood supply is impaired due to wounds of the mesentery, resection and end-to-end anastomosis are safer than closure. Exteriorization is never indicated in wounds of the small intestine.

Close attention should be paid to searching out retroperitoneal wounds in the fixed portions of the gastrointestinal tract. This is particularly true in the upper portion of the stomach, the duodenum, and the left colon, in view of the fact that a wound of entrance in the viscus, if not tangential, indicates a wound of exit. Retroperitoneal hematoma is often indicative of such extraperitoneal perforation. Mobilization of the right or left colon by incision of the lateral peritoneum and reflecting the bowel medially gives ready access to the posterior surface of the bowel and to the retroperitoneal structures. Mobilization of the duodenum medially by incising the peritoneum at its lateral margin gives access to the posterior surface and to the retroduodenal portion of the bile duct as well as the posterior surface of the head of the pancreas.

In civilian life, most wounds of the colon may be closed primarily with safety. In the right colon, if the wound is large, devitalized margins may be excised and closure carried out around a large mushroom catheter brought out as a tube colostomy. Exteriorization of wounds of the right colon should be avoided whenever possible, since this procedure carries most of the disadvantages of ileostomy. Extensive wounds of the ileocecal region requiring resection of the involved segment are

better managed by resection and ileocolostomy rather than exteriorization. Small wounds of the left colon, including the sigmoid, are best treated by suture. Extensive wounds may be exteriorized or closed with a diverting proximal colostomy. Mobilization of the colon is usually necessary for exteriorization. Exteriorization and colostomy should be done through muscle-splitting wounds made away from the main incision.

Wounds of the extraperitoneal rectum may be closed from above or below when feasible, but should always have a proximal double-barrel diverting colostomy and drainage of the presacral area through a perineal incision in front of or lateral to the coccyx.

Ureters and Bladder. Wounds of the pelvis of the kidney and of the ureter, whether partial or complete, should be repaired with interrupted sutures of fine chromic catgut over a catheter splint which should extend from the pelvis of the kidney into the bladder. Polyethelene tubing is useful in this respect. Wounds of the ureter close to the bladder may be treated by re-implantation into the bladder. In the case of extensive loss of substance of the ureter, where approximation is impossible, the T-tube principle may be utilized, since the regenerative properties in the ureter are good. In such instances, pyelostomy or nephrostomy should be added. All wounds of the kidney and ureter should be drained, preferably through the flank. Intraperitoneal wounds of the bladder are closed primarily with two layers of continuous catgut suture, which should not include mucosa. The bladder is drained with a suprapubic catheter, which may be inserted through an existing wound. The perivesical spaces should be drained.

Female Pelvic Organs. Wounds of the normal female pelvic organs should be treated by general surgical principles with minimal sacrifice of tissue. If the pregnant uterus has sustained a penetrating wound with perforation of the membranes or the placenta, the uterus should be emptied by hysterotomy. Gutter wounds may be sutured. Blunt trauma, except for rupture of the uterus, which is rare, may be followed by abortion.

Closure. Before closure, meticulous peritoneal toilet should be carried out, removing all liquid and clotted blood, tissue fragments, foreign bodies and evidences of soiling.

Laparotomy wounds should be closed in layers, preferably with nonabsorbable suture material and with through-and-through stay sutures, since these wounds have a high incidence of evisceration. In

many cases, through-and-through closure alone with heavy suture material may be more expeditious. Stay sutures and through-and-through sutures should be left for a minimum of three weeks. In the case of extensive loss of substance from the musculofascial structures of the abdominal wall, closure may be accomplished by mobilization of skin and closing the skin only, leaving the hernia to be repaired at a later date. If there is appreciable tissue damage about the wounds of entrance and exit, they should be thoroughly debrided.

Genitourinary Tract and Perineum. In nonpenetrating injuries of the upper urinary tract where exsanguinating hemorrhage is not a factor, operation may be avoided or postponed until more adequate diagnostic procedures have been undertaken. Such injuries to the kidneys may range from minor contusions with hematuria to major fragmentation. Intravenous urography will give an indication of the function of the opposite kidney, but in severe injuries may show merely absence of function on the involved side. Retrograde urography may demonstrate extravasation of dye into the substance of the kidney or into the perinephric area. In the latter case, exploration and drainage of the perinephric space are indicated, with suture, nephrostomy or, as a last resort, nephrectomy. In civilian life most injuries of the bladder occur in connection with fractures of the pelvis.

Bladder injury should be suspected in every case of such fracture and immediate catheterization carried out. If the catheter does not enter the bladder readily, urethral injury should be suspected. If no urine, grossly bloody urine, or blood only is obtained from the bladder, a careful cystogram may be done. If this indicates extravasation or if a measured quantity of fluid introduced into the bladder cannot be recovered, immediate surgery should be carried out to (1) suture the wound of the bladder, (2) perform suprapubic cystostomy (high above the symphysis), and (3) drain the perivesical area.

Wounds of the urethra may be classified as above or below the triangular ligament. The posterior urethra is most often involved in fractures of the bony pelvis and the bladder neck may even be torn away from the triangular ligament. In such instances catheterization will be impossible. Blood will be seen at the meatus, retention of urine usu-

ally occurs, and the perineal swelling of urinary extravasation may be seen. Rectal examination may show abnormal mobility of the prostate. Combined suprapubic and perineal exposure is carried out and a sound introduced from above to meet a sound introduced upward through the urethra. If contact can be established and the lower sound brought up into the bladder, a small catheter passed over its end may be drawn out through the urethra and used to draw a Foley bag catheter into the bladder. The bladder neck may then be pulled down to the triangular ligament by traction on the Foley catheter. The apex of the prostate must always be firmly sutured to the pelvic floor to eliminate any dead space between the prostatic apex and the membranous urethra, and to avoid serious stricture later. Wounds of the pendulous urethra should be treated by exposure and repair over a catheter with interrupted chromic catgut sutures. Some urologists feel that the urethral catheter should be removed immediately and the urethra kept dry by cystotomy tube which is removed when the urethral wound is well healed. Associated injuries to Buck's fascia and to the corpora should be repaired and large hematomas drained.

When denudation of the penis occurs, skin coverage should be supplied as early as possible by split thickness grafts or implanting the penis in a scrotal tunnel if necessary. In avulsion of the scrotum, the testes should likewise be covered in skin tunnels. Injuries to the testes should be repaired with the greatest conservation of tissue possible, and orchidectomy carried out only as a last resort.

Injuries to the female urethra are rare and should be repaired over a catheter. Other wounds of the perineum should be treated by general surgical principles of cleansing and repair.

POSTOPERATIVE CARE AND COMPLICATIONS

Following laparotomy, in addition to the usual nursing care with close watch on temperature, pulse, respiration, and blood pressure, continuous nasogastric suction should be maintained until adequate peristalsis and bowel function are present. The indwelling urethral catheter should remain as an adjunct to measurement of intake and output until fluid and electrolyte balance are satisfactory or longer in the case of lower urinary tract wounds. Particular attention must be paid to the need for further transfusion and to fluid and electrolyte balance. Broad spectrum antibiotics should be used in most cases. If history of pre-existing disease was not obtained preoperatively, it should be sought and appropriate therapy carried out.

The most common complication following wounds of the abdomen is peritonitis and retroperitoneal infection. One of the usual causes of peritonitis is an overlooked wound of the gastrointestinal tract, which as noted above may be most frequent in the upper portion of the stomach, the area of the duodenum, and the colon. Infection may also follow failure to adequately cleanse the peritoneal cavity of dead tissue, clots, foreign bodies, or to adequately drain blood and secretions. Reoperation, except for drainage of localized abscesses, is seldom indicated. Careful daily examination should be made for wound infection, subphrenic, pelvic, pericecal, and retroperitoneal abscesses, which may be masked by antibiotics and smolder along for days or weeks without being recognized.

Dr. Leon Goldman Appointed Head of Congress Committee

DR. LEON GOLDMAN will be the chairman of the Advisory Committee on Arrangements for the Clinical Congress in 1960 when it convenes in San Francisco from October 10 through 14.

Dr. Edwin J. Wylie is to be vice chairman, and members of the committee are Drs. John E. Adams, Edmond Dana Butler, Roy B. Cohn, R. Glenn Craig, David J. Dugan, Maurice Galante, Walter E. Heck, Frank Hinman, Jr., Nelson J. Howard, Floyd H. Jergesen, and Harry N. Jurow.

Dr. Goldman

Also on the committee are Drs. Donald E. King, Russell R. Klein, James L. MacDonald, George W. Magladry, Jr., Earl H. McBain, Dexter N. Richards, Jr., Victor Richards, and Benson B. Roe.

Telecasts of surgical procedures will emanate from Stanford University Hospitals. Television will be the project of Dr. John E. Connolly as local chairman; and Dr. Edwin H. Ellison, Milwaukee who is in charge of all College TV.