

## CHAPTER XIV.

### INJURIES OF THE STOMACH AND INTESTINE.

#### SUBCUTANEOUS INJURIES OF THE STOMACH AND INTESTINE.

INJURIES of the stomach and intestine have so much in common that it is better to consider them together. Indeed it is frequently impossible to make a differential diagnosis between the two. And the important point to determine is not which portion of the alimentary tract has been injured, but does or does not an injury of the alimentary tract exist. Subcutaneous injury of the stomach or intestine is usually the result of some force acting directly upon the abdomen, though in rare instances it may be produced by a violent jarring of the whole body. Some of the commoner injuries are a kick from a horse, the passage of a wagon-wheel over the abdomen, a blow from a fist or with a ball, a crush between railroad cars, a fall on a sharp angle or upon water. In rare cases a violent contraction of the abdominal muscles may result in rupture of a healthy stomach.

The trauma may be diffuse or circumscribed. The force usually strikes the abdominal wall in the immediate neighborhood of the organ which it injures, but this is not always the case. For example, a blow in the hypogastrium may rupture the stomach situated in the epigastrium. In rare instances force which is not applied directly to the abdomen may injure some abdominal organ. An example of this is a fall upon the feet. Such an injury is apt to be associated with intra-abdominal hemorrhage.

Injuries of the abdominal wall have been considered elsewhere. The lesions here considered may be classified under three heads:

1. Rupture of an organ which is more or less full of gas or fluid.
2. Tearing of an organ from its attachments.
3. Contusions.

The two first kinds of injury are due to stretching of the organ beyond the limit of its elasticity. The stomach usually ruptures along its lesser curvature, and the intestine at some point opposite the mesenteric attachment, whereas if the organ is torn it is almost always in the neighborhood of its attachment. This lesion is almost never seen in connection with the stomach. Parts of the intestine most often torn are the junction of the duodenum and jejunum and the ileocaecal region.

A contusion is either the result of a circumscribed force—for example, a kick; or it occurs when the injured organ is pressed against some unyielding part of the body, such as the vertebral column or the pelvic bones. The latter is the usual form of injury. In most cases

the organ is injured in two opposite places which have been pressed together.

Subcutaneous injuries are not equally common in all portions of the abdomen for the reason that the anatomical relations of organs, their relative fixation, distention, etc., play an important part in their injury or escape from injury. The stomach is protected by the ribs and is relatively seldom ruptured. Petry collected records of 219 subcutaneous injuries of the alimentary canal, and found that the stomach was involved 21 times, the small intestine 172 times (duodenum 9 times, jejunum 46 times, ileum 85 times), and the large intestine 26 times (caecum 7 times, ascending colon 8 times, transverse colon 4 times, descending colon 2 times, sigmoid 5 times).

Rupture is relatively more frequent in old individuals than in young ones.

Injury of the stomach or intestine may be of different degrees of severity. The lesions may be divided into contusions, non-perforating injury, and perforations.

A contusion is usually the result of crushing, rarely of overstretching of the intestinal wall. It may be so slight that there is no hemorrhage, or so severe that it leads to necrosis and subsequent perforation. A slight contusion heals without a scar, the extravasated blood being resorbed. Hemorrhage occurs most often in the submucosa. It may loosen the mucous membrane for a considerable distance and by depriving it of nourishment cause it to necrose. As a result of such injury as much as 150 cm. of intestinal mucous membrane has been known to pass per rectum. Interstitial hemorrhage is not always followed by necrosis of the mucous membrane. Traumatic ulcer due to necrosis of the mucous membrane will be considered in a subsequent chapter.

A contused area may be marked by minute hemorrhages, or an extensive diffuse hemorrhage which shows the characteristic colors of degenerated blood, or the affected portion may show the black color of necrosis.

Non-perforating injuries may be of the nature of contusions, or they may be partial ruptures due to increased tension within the organ, or in rare instances to tension from without. These tears are generally fairly straight and have smooth edges. But there are so many variations in the appearance of both contused and torn wounds that it is impossible to say from the appearance of the part how the injury was produced. The mucous membrane may be alone affected, or the mucous membrane and muscular coats, or the muscular and serous coats, or the serous coat alone. Injuries of the mucous membrane may be superficial or deep, and may open small or large vessels. It is rare that the serosa is the only coat injured, although this may be true even of circular wounds which extend throughout the circumference of the bowel.

If the muscular coat is torn, there is separation of the edges of the wound. If the serous and muscular coats are both torn, the mucous

membrane projects in the form of a hernia which will subsequently increase in most cases.

Perforation may be due to rupture from increased tension or tearing or crushing. A perforated wound due to crushing may have smooth edges. Such a wound may follow the kick of a horse. The immediate effect of a perforating wound is contraction of the muscular coat, which after about six hours is followed by paralysis. The loose mucous membrane crowds into the wound, so that if the perforation is small the membrane may block it completely and prevent the escape of intestinal contents. Larger openings gap and allow feces to escape. Even if the small intestine is torn clear across, contraction of

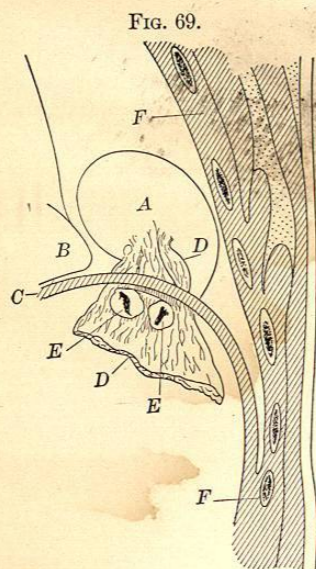


FIG. 69.  
Strangulation of the stomach through a rent in the diaphragm: A, hernial sac in the pleural cavity; B, pericardium; C, diaphragm; D, omentum passing through the diaphragm, together with E, cut transverse colon; F, chest-wall. (Mackenzie and Battle.)

the circular muscles will often close its lumen for a short time and prevent the escape of its contents. Soon, however, the mucous membrane projects and holds the lumen open.

In the first hours after injury it is impossible to differentiate between perforating and non-perforating injuries of the stomach and intestine. The later symptoms of these two classes of injuries and their outcome are widely different.

**Non-perforating Injuries.**—Little is known of the exact conditions of non-perforating injuries of the stomach, since for the most part they heal spontaneously. Unless the patient dies of injury of some other portion of the body so that an autopsy is performed, the diagnosis remains a probable one. Even if an ulcer develops later, the condition of the stomach immediately after the injury can only be surmised. In Petry's collection of 24 cases of subcutaneous injury of the stomach 4 were classed

as contusions with recovery in every instance. In 2 instances injury led to an ulcer which was recovered from, and in 2 instances the resulting stricture of the pylorus was relieved by operation. A rare result of non-perforating injury of the stomach is shown in Fig. 69. The immediate effect of a traumatism of the stomach, whether perforating or not, is shock. This may, of course, be due to injury of any other abdominal organ, or even to injury of the abdominal wall. The injury of the stomach itself may produce no further symptoms, or it may cause pain, vomiting, and hemorrhage. Of course, every tear of the mucous membrane of the stomach no matter how slight produces some hemorrhage, but if the quantity of blood is small it will not be vomited and may pass unnoticed in the stool. Moreover,

contusions and injuries of the intestine, as well as injuries of the abdomen without traumatism of the stomach or intestine, may be followed by gastric hemorrhage.

**Symptoms.**—The late symptoms of injury of the mucous membrane without perforation are due to the ulcer which follows. In rare cases an abscess forms in the gastric wall, or it becomes the seat of diffuse inflammation. Contusions and non-perforating wounds may lead to necrosis and secondary perforation.

**Treatment.**—The treatment of non-perforating wounds of the stomach is purely symptomatic. The treatment of hemorrhage is exactly that of a fresh gastric ulcer. The stomach is protected as much as possible. Pain is to be controlled by an ice-bag upon the abdomen. Narcotics should be withheld for a few hours lest they obscure the differential diagnosis between perforating and non-perforating wounds.

**Perforating Injuries of the Stomach.**—Perforating injuries of the stomach, for the most part of the nature of rupture, are usually found in the lesser curvature near the pylorus, but less often in the neighborhood of the cardia, and less often still in the anterior wall. The rupture is generally longitudinal. Usually some other organ is injured—for example, the liver, spleen, or pancreas. Rupture of the stomach has in several instances followed a slight traumatism such as violent contraction of the abdominal muscles. Such an accident is more likely to occur in an individual who has been drinking. Furthermore, if the gastric wall is weak in any point as a result of an ulcer or cicatrix, perforation will be more likely to follow a comparatively slight injury.

**Symptoms.**—The symptoms of rupture of the stomach or intestine are sufficiently characteristic. They are: 1, well-marked shock; 2, local symptoms referable to the perforation; 3, symptoms due to the effect of perforation on the general peritoneal cavity. If the patient does not lose consciousness, he complains of intense pain, most marked in a limited area at the site of perforation. In rare cases the patient is not much affected by the rupture and walks or rides for miles. Usually shock appears in a short time, and the senses are dulled possibly to a degree of coma, or the patient may become exhausted. There is pallor, with sunken countenance, a small, irregular, and frequent, or in rare instances very slow pulse. Respiration is frequent and irregular, perhaps of the Cheyne-Stokes type. The skin is cool and the body temperature is less than normal. The patient may die in shock as the result of cardiac paralysis. This is, however, rare unless the injury is extensive. Usually the first shock passes over, the patient's senses return, and his pulse and appearance improve.

The intense localized pain continues. It is not much increased by pressure, but there is little characteristic about it. There is usually vomiting. This is relatively more frequent after perforation of the intestine than after perforation of the stomach, perhaps because the gastric contents escape more readily into the peritoneal cavity. The

vomitus may be bloody. According to Angerer, repeated bilious vomiting indicates a perforation of the stomach, while non-perforating wounds are followed by only one or two attacks of vomiting. Eructations and nausea are also present.

The abdominal muscles are soon firmly contracted, and may be as hard as a board so that the abdomen is hollow. If this symptom continues for hours, the probability of perforation of the stomach or intestine is great. The cremaster muscle is also strongly contracted, according to Trendelenburg. The abdominal walls are frequently hyperæsthetic. Respiration is thoracic.

Sooner or later symptoms appear which are due to the escape of gastric or intestinal contents into the peritoneal cavity. Gas rises to the portion of the abdomen which is uppermost, while fluid seeks the lowest portion. Whether or not these differences are well marked will depend upon the quantity of escaped fluid and gas. As the patient lies upon his back the highest point of the abdominal cavity is in the middle of the epigastrium. Even a small quantity of free gas may be demonstrated here, since it will replace the normal hepatic dulness by a circumscribed area of tympanitic resonance. Percussion with a hammer upon a pleximeter produces a metallic clang. A larger collection of gas obscures the whole area of hepatic dulness.

Escaped fluid gives the usual symptoms of free fluid in the peritoneal cavity. Dulness in the most dependent portion changes with change in the position of the patient. Seigel says that the dulness first appears on the side on which perforation is situated. As the fluid and gas increase the previously sunken abdominal wall becomes distended and the condition changes to that of perforative peritonitis or to that of peritoneal sepsis. The abdomen becomes more and more distended as the result of the formation of gas in the paralyzed intestine and as the result of increased peritoneal secretion. The abdomen is everywhere tender, the pulse becomes smaller, more rapid and softer, and there is an increase of temperature. The patient is collapsed, and hiccup and vomiting ensue. The urine is scanty or secretion is suppressed as the result of reflex action upon the kidneys. If present, it contains albumin and indican. There is no movement of the bowels or passage of gas per anum. Bloody stools indicate a non-perforating injury of the mucous membrane. In brief, the symptoms of peritonitis develop which are given in detail in Chapter X. of this volume, continuing with more or less intensity until death.

While the group of symptoms above given is sufficiently characteristic, the diagnosis in certain cases is difficult. Shock may not be present and the patient may express himself as feeling well. On the other hand, shock may be due to traumatism without injury of the abdominal organs. The initial pain is never wanting, but may be due to simple injury of the abdominal wall. Moty advises letting the patient drink water, which if perforation exists will cause a sudden increase of pain. This test seems dangerous and has been seldom applied.

Vomiting is first seen in non-perforating injuries of the alimentary tract and may be wanting after perforation. Blood in the vomitus or in the stools is not a reliable sign of perforation. Even the signs of free fluid in the abdominal cavity may be due to profuse hemorrhage, and the early symptoms of abdominal injury which lead to such a hemorrhage may be the same as those of rupture of the stomach or intestine. Usually, however, hemorrhage may be known by the acute and rapidly increasing anæmia. Even here one may be mistaken, for acute peritoneal sepsis following perforation may produce a small rapid pulse, pallor, rapid respiration, and subnormal temperature, symptoms similar to those seen in acute anæmia. Dulness due to the presence of free fluid is not usually observed unless the quantity of such fluid is considerable. The most important single symptom is therefore the presence of gas in the peritoneal cavity, but this is not always easy to determine. A high degree of meteorism may by turning the liver backward cause the area of hepatic dulness to disappear, or distended coils of intestine may come to lie between it and the anterior abdominal wall. On the other hand, perforation may be present without alteration of the area of hepatic dulness.

Schmidt emphasizes the importance of a well-marked tone of tympanitic resonance directly over the perforation. Gluzinski says that when there is free gas in the peritoneal cavity the cardiac and respiratory sounds can be heard more plainly than usual. Adamson and Crawford have heard a tinkling sound in the obstructed region synchronous with the heart or with respiration; but this sound has also been heard in cases of marked gastric dilatation. Senn distends the stomach or intestine with hydrogen gas. If the abdominal cavity is opened, the escape of gas can be observed; if the abdominal cavity is closed and perforation is present, free gas will collect in the highest part of the abdomen and obscure the hepatic dulness. This test is dangerous and should not be tried except when laparotomy is to be immediately performed. Mikulicz in one case obtained combustible gas from the peritoneal cavity by aspiration in a case of rupture of the stomach occurring during an alcoholic debauch. In rare cases subcutaneous emphysema follows the escape of gas into the peritoneal cavity. In many cases one must be content with a diagnosis of rupture of some portion of the alimentary canal. Indeed, such a diagnosis is satisfactory, since the subsequent treatment is practically the same in all cases. Rupture of the stomach or large intestine is usually followed by less violent symptoms than rupture of the small intestine. Gastric contents are less rich in virulent bacteria, and the contents of the large intestine owing to their solidity do not so readily escape. Vomiting of blood indicates injury to the stomach. Simple vomiting is in no wise characteristic.

**Diagnosis.**—In making a differential diagnosis of perforation, the character and the seat of injury are of importance. A lesser injury may serve to rupture the stomach, especially if it is overloaded. A given force is more likely to produce perforation if the object which

comes in contact with the abdominal wall is rather sharp. The condition of the abdominal wall is also important, since a relaxed and thin wall gives the abdominal organs less protection than a firm and thick wall.

The period of shock may pass directly into one of peritonitis, or the symptoms of perforative peritonitis may develop without a previous period of shock.

If the patient recovers from the traumatism, and after an interval comparatively free from symptoms, the signs of perforation develop, the condition is spoken of as late perforation. Such a delay in the symptoms may be due to temporary closure of the perforation by prolapsed mucous membrane aided by an empty condition of the organ and contraction of its muscles, or escape of contents may have been temporarily prevented by fibrinous adhesions to the neighboring peritoneal surface. Still another cause of late perforation is necrosis of the wall of the organ following contusion. Perforation of this sort takes place at the end of the first or the beginning of the second week.

Perforation is not always followed by escape of gastric or intestinal contents. If the conditions are particularly favorable, peritoneal adhesions may close the opening and lead to spontaneous cure. Such adhesions may also give way after weeks and allow peritonitis to develop. Perforation may also take place in an isolated portion of the peritoneal cavity, and the abscess thus formed may later break into the intestine or into the general peritoneal cavity, or the pleura, or through the abdominal wall, or its contents may be resorbed in the course of weeks or months. Finally, rupture may take place at some point not covered by peritoneum and lead to the development of cellulitis or a retroperitoneal fecal abscess. This is especially true of rupture of the ascending or descending colon or the duodenum.

Even when gastric or intestinal contents escape into the general peritoneal cavity the symptoms may be comparatively mild. Such a favorable course of the trouble indicates that the ruptured organ was empty and contained few virulent bacteria. If adhesions follow, they may close the perforation and the patient recover; or, as is more likely, a circumscribed peritonitis develops about the perforation and gradually spreads throughout the general peritoneal cavity in the form of fibrinopurulent peritonitis. The course and symptoms of different forms of peritonitis are described elsewhere in this volume.

**Prognosis.**—The prognosis of rupture of the stomach or intestine is very unfavorable if operation is not performed. There is no question that some patients recover spontaneously. One should not forget, however, that a patient whose perforation is closed by a limited fibrinous peritonitis is in the greatest danger until the healing processes are complete. In many of the cases which have been reported as instances of spontaneous recovery the diagnosis of rupture of the stomach or intestine is an extremely doubtful one. The symptoms described might equally as well have been due to a contusion or other non-perforating injury. Without autopsy it is difficult to say positively in these mild

cases that a perforation existed. Such a diagnosis is far more difficult to make than is the diagnosis of perforation due to simple gastric ulcer, for in the latter case the symptoms are not obscured by those due to traumatism. Spontaneous recovery may also follow perforation due to ulcer, but here too such a fortunate outcome is extremely rare.

The results of operation are relatively good. Petry found 44.5 per cent. of recoveries among 18 patients operated upon within twenty-four hours of rupture, and 25 per cent. of recoveries among 24 patients operated upon more than one day after rupture.

**Treatment.**—The treatment of acute perforation of the stomach or intestine should therefore be by operation. This should be performed as early as possible—before peritonitis has time to develop. But even if the patient is not seen until some time has elapsed, operation is still indicated as giving him a slight chance of recovery, while without operation the outcome is almost certain death. Lahoda saved a patient by operation eighty hours after traumatic rupture of the stomach although intense peritonitis had already developed. The rule ought to be therefore to open the abdomen, even though peritonitis is present, if the patient's general condition is such that he can endure operation.

There are two objections to early operation, namely, the uncertainty of diagnosis and the possible existence of shock. The surgeon may be mistaken in assuming that an intraperitoneal hemorrhage is a perforation; but this mistake is of comparatively little practical importance, since either condition should be treated by operation. A more serious error is to mistake for a rupture a simple contusion or other non-perforating lesion, especially of the mucous membrane. In doubtful cases a positive diagnosis cannot be made until the appearance of peritonitic symptoms. If one waits for these, the most favorable time for operation will have passed. Hence it is better to operate when a probable diagnosis of perforation can be made. A small incision will suffice to confirm or reject such a probable diagnosis, and will not subject the patient to much risk.

It is advisable to wait until the first intense shock has abated. If the shock does not diminish in a few hours or if it increases, one may fairly assume that it is not due to traumatism alone, but rather to commencing peritonitis, since, as stated above, the shock of traumatism may pass directly into that of peritonitis. If such be the case, operation by combating the cause of the shock will be the best treatment for it. Anæsthesia is not counterindicated by existing shock, and indeed the patient's condition often improves after administration of the anæsthetic.

If the diagnosis is uncertain and the stomach is known to be empty, it is safe to wait for twelve hours before opening the abdomen. Such a patient should be carefully watched. If no symptoms of peritonitis develop within twenty-four or forty hours, the operation should be postponed. This expectant treatment is also allowable if a well-localized peritonitis develops a day or more after the injury. If operation is performed in the intermediate stage of such a condition, there will be risk of infecting the general peritoneal cavity, while if the patient

is let alone the localized peritonitis may pass away of itself when the peritoneum has resorbed a small quantity of pus and gastric contents, or it may lead to a circumscribed abscess which can be opened at a later date.

Operation is performed as follows: If it is certain that the stomach is ruptured, the incision is made in the epigastrium. If the site of the perforation is unknown, a hypogastric incision is preferable. The existence of perforation is usually recognized as soon as the peritoneal cavity is opened, from the escape of free gas or the presence of gastric or intestinal contents. Gastric contents may be recognized by their appearance and odor and acid reaction. Eichberg says that the liver and spleen take on a bluish-gray color from even a small amount of free gas in the peritoneal cavity. This sign may be of value in doubtful cases. Senn's use of hydrogen gas in the presence of perforation has already been spoken of. If operation is performed more than twelve hours after perforation, there will usually be found well-marked signs of peritonitis which will guide the operator to a perforation.

If the diagnosis of perforation is made, the exploratory incision is carried upward—in case of the stomach even to the ensiform cartilage. One should not hesitate to give himself the benefit of the widest incision so that the inspection and cleansing of the peritoneal cavity may be thorough. A perforation in the anterior wall of the stomach is easily found. One in the neighborhood of the cardia is seen with difficulty. It is necessary to divide the gastrocolic ligament or the lesser omentum in order to explore the posterior wall of the stomach unless a rent in the anterior wall of the organ enables the operator to examine its posterior wall from within its cavity. As soon as the perforation is found it should be surrounded with a temporary tamponade, as described on page 213. An opening in the stomach should be closed by two rows of sutures. It is not necessary to trim the edges of the wound unless they are badly bruised. The best indication that tissue is in good condition is the fact that it bleeds freely when cut. When the perforation has been closed, the peritoneal cavity should be cleansed. If gastric or intestinal contents have escaped, a considerable portion of the peritoneal cavity will usually have been soiled and a thorough cleansing can only be obtained by irrigation. A hot (40° C., 104° F.) 1 per cent. sterile salt solution is best for this purpose. Every nook of the whole peritoneal cavity from the diaphragm to Douglas's pouch should be irrigated. Fortunately this irrigation tends to overcome the symptoms of collapse. A large quantity of fluid is required—from 20 to 40 litres (quarts). If the means for such thorough irrigation are not at hand, it is better not to irrigate at all, but to wipe the peritoneal cavity with gauze moistened with hot sterile salt solution or even with dry sterile gauze. An imperfect irrigation is worse than none because it tends to spread the infectious material throughout the peritoneal cavity. The abdominal cavity should be closed except in cases of well-marked peritonitis, when a Mikulicz tampon or Rehn tube for

irrigation (pages 177 and 219) may be employed. Closure of the peritoneal cavity even in cases of peritonitis is rendered possible by the thorough irrigation spoken of above. The treatment of advanced peritonitis is described in Chapter X.

Sometimes the surgeon fails to find the perforation either on account of its median situation or because the general condition of the patient does not permit of a protracted search. Sometimes the perforation when found cannot be closed for similar reasons. In such cases the region of the perforation should be treated by tampons.

After operation the patient should be kept absolutely quiet and for two or three days should receive nothing by mouth, not even water. Fluid should be given by rectal injections, and if these do not succeed in quenching his thirst subcutaneous injection of saline solution should also be administered. In three or four days the administration of fluid by mouth can be commenced and the diet regulated according to the principles given on page 224. The alimentary tract may be kept quiet by the administration of opium, and in addition morphine in case the pain is severe. It is better not to give narcotics until the diagnosis is made with certainty, but when this has been done there is no objection to their administration. Narcotics should not be given when perforation is suspected but for one reason or another operation is delayed. Moreover, in these doubtful cases the diet and other treatment of the patient ought to be as carefully regulated as when perforation is known to exist.

The question has been raised whether a patient supposed to have suffered from perforation of the stomach or intestine ought to be transported to a hospital. This is in general inadvisable, but if it has to be done it is far less injurious in the first hours after the injury than at a later period. On the other hand, it must be remembered that laparotomy for the purpose of finding and closing a perforation of the stomach and intestine is a difficult operation which cannot be carried out successfully unless there are reasonably good facilities. Therefore, there are many cases in which it is better to take the risk of transportation rather than the greater risk of operating in unsuitable surroundings.

#### PUNCTURING WOUNDS OF THE ABDOMEN WITH INJURIES OF THE STOMACH OR INTESTINE.

Injuries of the abdomen which lead to opening of the peritoneal cavity are spoken of as puncturing or perforating wounds. They are usually accompanied with injury of some abdominal organ. They may be caused by some sharp object, as a stick, or horn, or dagger, or by firearms. Gunshot-wounds of the abdomen constitute about 6 per cent. of all gunshot-wounds. Stab-wounds of the abdomen form a far less percentage of all stab-wounds. Whether an abdominal organ is injured depends largely upon the surface which it presents. In case of the stomach this varies greatly with its distention. The probability of injury of an abdominal organ also rests upon the shape and size of

the instrument and the force with which it strikes against the abdominal wall. The stomach and intestine are not so likely to be injured by dull objects as by sharp ones, and they are less likely to be injured by a bullet of lesser velocity than by one of great velocity. However, instances are known in which bullets of the highest velocity have passed clear through the abdomen without injuring the intestine.

According to Fischer's army statistics, the intestine was injured in 60.9 per cent. of gunshot-wounds of the abdomen, the liver in 16 per cent., the stomach in 7.4 per cent., the spleen in 2.7 per cent., and the pancreas in 0.4 per cent. Siegel collected records of 225 cases of puncturing gunshot- and stab-wounds of the abdomen, and found that 33.3 per cent. were of the stomach, 28.5 per cent. of the duodenum, 16.5 per cent. of the liver, 11.6 per cent. of the large intestine, 7.1 per cent. of the spleen and kidneys, and 7.1 per cent. of other organs. In 146 cases collected from German literature of gunshot injuries received in time of peace the traumatism was distributed as follows: 19 per cent. to the abdominal wall alone, 28 per cent. to the small intestine, 24 per cent. to the liver, 24 per cent. to the stomach, 19 per cent. to the large intestine, 12.3 per cent. to the spleen, 0.2 per cent. to the pancreas, 0.13 per cent. to the gall-bladder. In these figures every injury is counted, so that cases in which more than one organ was injured appear more than once.

From these and similar statistics it is clearly shown that the probability of internal injury in perforating wounds of the abdomen is extremely great. The probability, according to Siegel, is as high as 30 to 1. Tautzseher says that puncturing stab-wounds are more frequently uncomplicated than puncturing gunshot-wounds. There is also a difference in the frequency with which the stomach is wounded in times of peace and war, which may perhaps rest upon the fact that the stomach is more often empty in times of war than it is in times of peace.

If the puncturing wound is a large one, and even if it is not so large, the abdominal organs may prolapse through it. The omentum is the organ which is most frequently found in a wound. Such a prolapsed organ is not necessarily injured, or, if the organ which is prolapsed is injured, one must not assume that other organs are not also injured. The pleural cavity may also be opened in a puncturing wound of the abdomen. Coexisting injury of the stomach or intestine is almost always a perforation. If the wall is not completely perforated, the injury is usually confined to the serous or the serous and muscular coats. As such injuries have already been described (p. 255) they will not be further considered here. A stab-wound usually produces a single opening in the stomach, and a bullet two—one of entrance and one of exit. Other organs are more likely to be injured at the same time in the case of gunshot-wounds than in the case of stab-wounds. In stab-wounds the size of the opening corresponds more or less to the instrument by which it is caused and the edges of the wound are sharp. The perforation in a gunshot-wound corre-

sponds more or less to the size of the missile, but it may be much greater, especially in the case of the stomach and intestine. In exceptional circumstances it may be considerably smaller than the projectile which has caused it. The more nearly the projectile strikes the wall of the organ at a right angle the smaller will be the wound. The character of the wound depends also upon the kind of projectile and the rapidity with which it passes through the body. In general the wound of entrance of the stomach or intestine is smaller than the wound of exit, but differences in the angle which the stomach-wall presents to the course of the projectile make exceptions to this rule. The opening may be a smooth round one or irregularly torn. The edges of the wound are often contused, especially if the shot has passed obliquely. The mucous membrane projects into the wound, and may even occlude a small wound. This closure, according to Klemm's experiments upon animals, can only take place in case the perforation is less than 0.5 cm. (0.2 inch) in diameter.

**Symptoms.**—The symptoms of a penetrating wound of the stomach or intestine are essentially the same as those of subcutaneous perforation plus symptoms due to the wound in the abdominal wall and possibly prolapse of abdominal organs. The diagnosis is often evident. Under certain circumstances it may be extremely difficult. Sometimes it is not easy to say whether a wound is a perforating wound; and even if it is not a perforating wound it may be accompanied with rupture of the stomach or intestine just as the latter may occur without wound of the abdominal wall. Such a complication is more likely to exist if the abdominal wound is caused by a blunt instrument than it is in stab- and gunshot-wounds.

It is just as important to watch the patient after a penetrating wound of the abdomen as when subcutaneous rupture of the stomach or intestine is suspected. Vomiting of blood and intra-abdominal hemorrhage are symptoms more often seen after penetrating wounds than after subcutaneous rupture. Such hemorrhage due to the rupture of a large abdominal vessel or to an injury of the mesentery may produce both local symptoms and severe general anæmia.

In rare cases a wound in the intestine will present itself in the wound in the abdominal wall and discharge the intestinal contents externally without soiling the peritoneum. In other rare cases fluid which has been discharged from the stomach or intestine into the peritoneal cavity will find its way out through the abdominal wound. But such evidences of internal injury are rare. If the abdominal wound is small, it contracts and is filled with a blood-clot or is stopped by the omentum. From the character of the injury, the direction of the projectile or instrument, and the shape of the wound itself one may draw a conclusion as to the probable injury of abdominal organs, but such conclusions are merely guesses. Experience has shown that with rare exceptions every penetrating wound of the abdomen is complicated by injury of some abdominal organ. The surgeon ought to be guided by this fact in his treatment of the patient.