

## SUBCUTANEOUS PERFORATION OF THE JEJUNUM\*

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THE number of deaths resulting from trauma to intra-abdominal organs has increased in the past decade. In some of these cases, death has occurred almost immediately, because of extensive injuries to the body, the intra-abdominal lesion forming only a part of the general picture and not, as a rule, the chief cause of death. In a great many instances, however, the patients have lived for many hours after the accident, subsequently dying directly as a result of trauma to the abdominal viscera. It is in these cases that earlier diagnosis and treatment might lessen the high mortality of these injuries. Abdominal injuries naturally separate themselves into two groups: (1) Percutaneous injuries, caused by foreign objects such as bullets, knives, and so forth, in which a penetrating lesion of the abdominal wall is present, and in which the diagnosis of injury to the underlying viscera is made relatively easy, and (2) subcutaneous injuries, caused by a blunt force applied directly to the abdominal wall or even indirectly to the body, as in falling, lifting, or straining. In these injuries, no evidence of trauma to the abdominal wall is present, and the diagnosis and method of treatment in these cases are often exceedingly difficult.

Geill<sup>11</sup> stated that subcutaneous injuries involved the abdominal viscera in the following order: liver, spleen, kidneys, intestines, stomach, bladder, and pancreas; the intestines were involved in 11.1 per cent of his cases.

Intestinal rupture is caused in three ways: (1) By crushing, in which the intestine is caught between some fixed structure such as the spine or pelvis and the direct force is applied perpendicularly to the abdomen; (2) by tearing, in which the force is applied tangentially to the abdominal wall, causing the bowel to be torn from its attachments, and often tearing the mesentery also, and (3) by bursting from increased intra-intestinal pressure exerted by fluid or gas caught in the bowel between angulations of the wall. In TABLE I are listed cases of rupture of the intestines reported by various authors and tabulated according to the situation of the perforation. In some cases, the site of rupture was noted as merely "small intestine" with no specific localization to the duodenum, jejunum or ileum; in other cases, no note was present concerning the situation of the lesion, while in still others, no perforation was found at operation. Allowing for these discrep-

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ancies, it is seen from TABLE I that the small intestine was the site of rupture in more than 90 per cent of the cases, the jejunum and ileum were involved about equally, and together accounted for about 80 per cent, while the duodenum and large intestine were involved in about 10 per cent of the cases. In reviewing the cases reported in the literature, it was noted that the beginning of the jejunum, just distal to the ligament of Treitz and the end of the ileum, in the region of the ileocecal attachment, were by far the most frequent sites of traumatic perforation. This is undoubtedly attributable to the limited mobility of these sections, and their proximity to fixed bony structures, so that conditions conducive to perforation are present when extreme force is applied to the abdomen.

TABLE I  
*Situation of Subcutaneous Ruptures of the Intestines*

Author	Duo- denum	Jejunum	Ileum	Cases Small intes- tine*	Large intes- tine*	Not noted	Total
Poland <sup>19</sup> .....	4	14	16	22	5	0	61
Curtis <sup>7</sup> .....	6	44	38	21	4	3	116
Makins <sup>15</sup> .....	1	6	7	2	5	0	21
Gage <sup>10</sup> .....	10	20	43	0	6	6	85
Lund <sup>14</sup> .....	0	5	6	5	1	2	19
Berry and Guiseppi <sup>3</sup> .....	26	32	32	25	10	7	132
Tschistosserdorff <sup>26</sup> .....	1	23	25	0	3	0	52
Battle <sup>1</sup> .....	32	111	59	2	11	7	221
Stanley <sup>24</sup> .....	0	3	1	0	0	0	4
Quain <sup>20</sup> .....	0	4	3	0	5	0	12
Massie <sup>17</sup> .....	4	14	8	3	1	4	34
Vance, <sup>26</sup> 1923†.....	3	4	5	0	2	0	12
Rowlands <sup>22</sup> .....	23	157	158	0	43	0	381
Richter† <sup>21</sup> .....	0	1	3	4	3	0	9
Vance, <sup>27</sup> 1928.....	0	3	4	3	0	0	10
Beekman <sup>2</sup> .....	0	0	2	0	0	0	2
Cooke <sup>4</sup> .....	3	6	2	0	1	0	12
Totals.....	113	447	412	87	100	29	1,183

\* Situation not given more definitely.

† Multiple ruptures.

Perforation of the intestines of children is not a very common occurrence; the liver is the organ most often injured in abdominal trauma in childhood. Beekman found only two cases among a series of 59 children admitted to the Bellevue Hospital with abdominal injuries. In TABLE II are listed some cases of rupture of the intestine collected from the literature, in which the age of the patient was given as 12 years or less. They are relatively few in contrast to cases of this injury occurring later in life.

JEJUNAL PERFORATION

TABLE II

*Data Concerning Subcutaneous Rupture of Intestines of Patients Twelve Years of Age or Less. The Quantities Given Here Are Included in Those Given in Table IV*

Author	Cases	Patients operated on	Died	Operative mortality, per cent	Died without operation	Total mortality, per cent
Poland.....	3	0	0	00.0	3	100.0
Curtis.....	2	0	0	00.0	2	100.0
Makins.....	4	4	4	100.0		100.0
Lund.....	2	2	1	50.0		50.0
Berry and Guiseppi.	24	13	9	61.5	11	83.3
Quain.....	4	4	1	25.0		25.0
Vance, 1923.....	2	2	2	100.0		100.0
Massie.....	8	5	3	60.0	3	75.0
Richter.....	11	9	3	33.3	2	45.4
Moynihan <sup>18</sup> .....	9	7	4	57.1	2	66.6
Vance, 1928.....	2	2	2	100.0		100.0
Beekman.....	2	2	1	50.0		50.0
White.....	1	1	0	00.0		00.0
Cooke.....	3	0	0	00.0	3	100.0
Totals.....	77	51	30	58.8	26	72.7

CASE REPORT

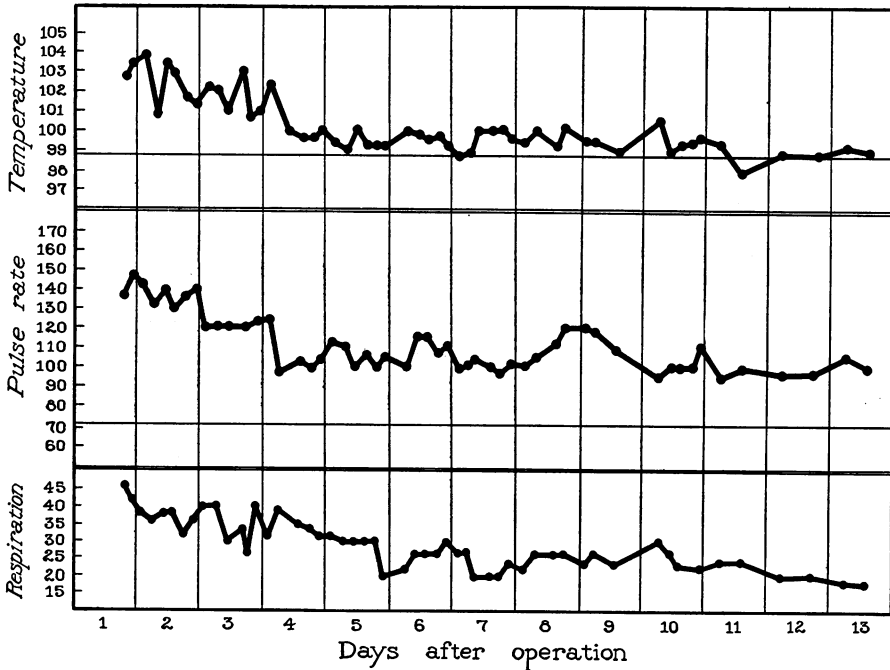
A white girl, 4 years 11 months of age, was admitted to the hospital November 28, 1934, complaining of abdominal pain. About two and one-half hours before admission, while playing, she had pulled a flower box, which measured about four feet by ten inches by ten inches (120 by 25 by 25 cm.), down upon herself. The box fell a distance of about three feet (90 cm.) with considerable force, pinning her beneath it. She was unable to extricate herself, but the box was removed after a few minutes. The child did not lose consciousness, and was able to arise and walk. Shortly thereafter she became nauseated and vomited. There was no hematemesis. She complained of some pain across the upper part of the abdomen, but this was not severe. An hour before she was brought to the hospital, the abdominal pain had become more severe, she had vomited again, had become cold and pale, and felt faint.

She presented a typical picture of shock; cold, moist extremities, marked pallor, respirations 46, thoracic in type. Pulse 136, weak and thready (Graph 1). The blood pressure could not be obtained (Graph 2). Immediate intravenous injection of 6 per cent solution of acacia was started, the foot of the bed elevated and heat applied to the extremities.

On physical examination no contusions, abrasions, or lacerations were found on the abdominal wall. There was tenderness, graded 3, throughout the abdomen, and rigidity, graded 3, of the abdominal muscles. The patient could not localize the abdominal pain to any particular area. Hepatic dulness was not obliterated nor was there any shifting dulness in the flanks. There was no abdominal distention, and the liver and spleen could not be palpated because of the tenderness and rigidity. The lungs were negative to percussion and auscultation. An occasional extrasystole could be heard over the apex of the heart. The reflexes were not abnormal and there was no paralysis. Erythrocytes 3,770,000, leukocytes 17,600, polymorphonuclears 55 per cent. According to the parents the patient had voided grossly normal urine before she came to the hospital. Urinalysis in the hospital disclosed albumin graded 1, a slight trace of sugar, and about six pus cells to the high power field. There were no erythrocytes in the urine. The child's condition

gradually improved, and after 350 cc. of solution of acacia had been given, her blood pressure was 110/60. Skin was warm. Pulse 136 but of better quality. It was apparent that she was suffering from a traumatic intra-abdominal lesion which required surgical treatment; therefore she was brought immediately to the operating room.

Under gas-oxygen-ether anesthesia a small right rectus incision was made, approximately five and one-half hours after the accident. As soon as the peritoneal cavity was opened, free fluid but no blood was encountered. Starting at the terminal part of the ileum, the entire small intestine was carefully examined, until about two inches (five cm.) distal to the ligament of Treitz, a perforation about one cm. in diameter was found. This was closed, and the area inverted with two continuous rows of chromic catgut. There was no evidence of injury to stomach, duodenum, large intestine, mesentery, liver, or spleen. It was felt safer to leave a small Penrose drain in the lower angle of the wound. The complete procedure took 35 minutes.



GRAPH 1.—Record of temperature, pulse and respiration.

Fluids were given intravenously, and in increasing amounts by mouth, until, on the sixth day, the child was taking a liquid diet. The temperature and pulse rate gradually returned to normal. The drain was removed on the tenth day. Skin sutures on the twelfth and the silkworm tension sutures on the thirteenth days, when the patient was dismissed from the hospital.

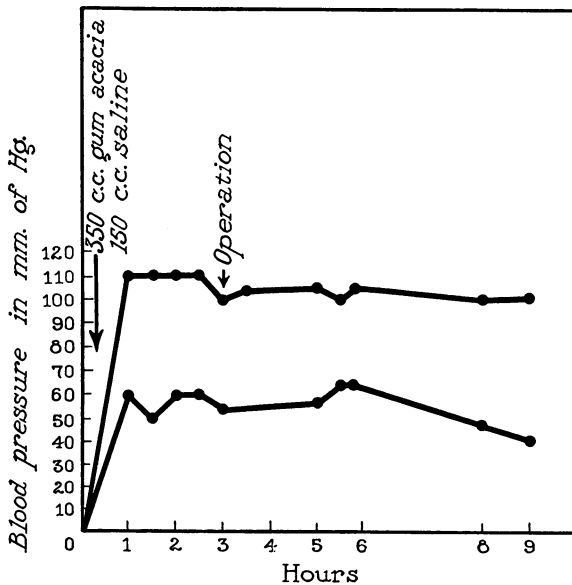
No one sign is pathognomonic of intestinal rupture, but the diagnosis has to be made from the general clinical picture, including the history and a carefully performed physical examination. In most cases, pain is the outstanding symptom. It is present usually from the beginning, is constant in duration, dull, aching and not colicky in nature. It is diffuse throughout the abdomen early, and may then become localized. White<sup>28</sup> reported a case of ruptured jejunum, in which the pain was localized to an area below and

### JEJUNAL PERFORATION

to the left of the umbilicus; the localization was similar to that of the pain of gastrojejunal ulcer.

A variable degree of shock is present. This may follow immediately after the injury, or may be delayed. Many reports of cases are found in the literature in which the patient felt well after the injury, except for the abdominal pain, and walked into the hospital apparently in good condition, only to develop the signs of shock later. With shock are present the cold, clammy extremities; rapid, thready pulse, and lowered blood pressure. Nausea and vomiting are present, and continued vomiting, especially after recovery from the initial shock, is a valuable early sign of intestinal perforation.

Tenderness is present but usually is of no aid in early recognition of



GRAPH 2.—Record of blood pressure.

the situation of the perforation, because it is usually diffuse. Rigidity of the abdominal muscles is probably the most valuable single sign of intestinal injury. It is present early in almost all the cases, is persistent, and even under the influence of morphine abates very little. Distention of the abdomen does not occur early, but is a manifestation of the peritonitis that later develops, and is a sign of poor prognosis when seen early.

Shifting dullness in the flanks early in the course is diagnostic of intra-abdominal hemorrhage, either from the mesenteric vessels or from the solid viscera. It is doubtful if, in early cases, enough intestinal content is present in the peritoneal cavity to produce this sign. Obliteration of the area of hepatic dullness, often mentioned by some as diagnostic of intestinal perforation, is seldom present in the early stages and is therefore useless as an early sign. One should look for it at the first examination, however, because its

detection at a later examination then becomes of diagnostic importance. Emphysema of the posterior abdominal wall is indicative of retroperitoneal rupture of either the duodenum or colon.

The pulse, temperature, blood pressure, and respirations are dependent on the presence or absence of shock. When the diagnosis is not obvious, a check on these vital signs every 15 minutes will often aid in establishing an early diagnosis, so that early surgical treatment can be carried out. The temperature, which at first is usually subnormal, rises after the patient recovers from the shock, and the pulse becomes slower and of better quality. A constantly rising pulse rate is of diagnostic importance, and if combined with an increased respiratory rate, surgical exploration is indicated.

Examination of the blood usually reveals moderate leukocytosis. When bleeding is present, either from the mesenteric vessels or from a solid viscus, the leukocytosis is more marked and there is a fall in the number of erythrocytes and in the hemoglobin content. Hourly examinations of blood should be made.

In regard to the diagnosis of intestinal perforation, then, it may be said that consideration of all the signs and symptoms is the important factor. No one sign or symptom is absolute, and no sign or symptom is to be disregarded. If a definite diagnosis cannot be made when the patient is first seen, careful observation, with repeated physical and blood examinations, as well as frequent determinations of the vital signs, should be carried out. It should be remembered that intestinal rupture may result from an apparently trivial injury, and also symptoms of rupture may be delayed. Cope,<sup>5</sup> in writing of the early diagnosis of this condition, stated that he would submit a patient to laparotomy if, in the absence of thoracic and renal injury, the following signs and symptoms were present: (1) severe abdominal pain persisting for six hours, accompanied by vomiting, gradually rising pulse rate, local rigidity, and deep local tenderness; or (2) absent or slight abdominal pain, with a steadily rising pulse rate, especially if the patient is restless and listless.

The importance of making an early diagnosis, and operating early, is seen from the figures presented by Siegel,<sup>23</sup> who studied the records of 376 cases in which operation was performed, and showed the increasing mortality as the time between the injury and the operation increases (TABLE III).

TABLE III  
*Mortality in Relation to Interval between Injury  
and Operation (Siegel)*

Time of operation in relation to time of the injury	Mortality, per cent
Within the first 4 hours.....	15.2
From 5 to 8 hours.....	44.4
From 9 to 12 hours.....	63.6
After 12 hours.....	70.0

JEJUNAL PERFORATION

From TABLE IV it is seen that the total mortality in both cases operated and nonoperated is about 73 per cent, approximately the same as that for children less than 12 years of age, as is seen in TABLE II. The operative mortality derived from the totals is about 60.7 per cent (TABLE IV) and it is

TABLE IV

*Data Concerning Subcutaneous Rupture of the Intestines of Patients of All Ages. The Quantities Include Those Given in Table II*

Author	Cases	Patients operated on	Died	Operative mortality, per cent	Died without operation	Total mortality, per cent
Poland.....	61	0	0	00.0	61	100.0
Curtis.....	116	12	12	100.0	104	100.0
Siegel.....	376	376	194	51.6		51.0
Makins.....	21	15	12	80.0	6	85.7
Kirstein.....	18	18	10	55.5		55.5
Gage.....	85	40	23	57.5	45	80.0
Eisendrath <sup>8</sup> .....	40	40	21	52.5		52.5
Lund.....	19	15	8	53.3	4	63.1
Berry and Guiseppi.....	132	84	67	79.7	48	87.2
Tschistossendorff.....	52	47	39	82.9	5	84.6
Lockwood.....	27	13	8	61.5	14	81.5
Battle.....	221	124	76	56.1	97	78.3
Stanley.....	4	4	1	25.0		25.0
Quain.....	12	12	5	41.7		41.7
Massie.....	34	24	17	70.8	10	70.6
Vance, 1923.....	12	5	5	100.0	7	100.0
Moynihan.....	61	47	35	74.4	14	80.3
Vance, 1928.....	10	10	5	50.0		50.0
Cooke.....	12	1	1	100.0	11	100.0
Totals.....	1,313	887	539	60.7	426	73.4

about the same, 58.8 per cent, for children (TABLE II). The high mortality is accounted for chiefly by the late operations, when peritonitis is developing or has developed. However, another reason for the high operative mortality is that patients are in a state of severe shock. Preparation of patients who are in shock is an important part of the treatment, and one of us (Counselor<sup>6</sup>) previously has pointed out the efficacy of 6 per cent solution of acacia in treating shock immediately, whether or not hemorrhage has taken place. Martin<sup>16</sup> has pointed out that following penetrating wounds of the abdomen, the important complications, in order, are shock, peritonitis, and hemorrhage. This is also true following subcutaneous injuries of the abdomen. Fraser and Drummond<sup>9</sup> have expressed the belief that very little intestinal leakage occurs from the perforation during the first six hours because peristalsis is absent and because the everted mucous membrane acts as a plug. Even in complete tears, according to the belief they expressed, the leakage is not great during the early hours, because of the contraction of the circular muscle layer in the severed ends. This substantiates the belief that immedi-

ate operation on a patient who is in shock only adds insult to injury, and that it is better to improve the patient's condition first by means of measures to combat shock. The immediate treatment then becomes the treatment of shock when it is present, but if shock is absent, one should not wait for it to appear but immediately perform laparotomy.

The outlook is better for patients whose perforations are high in the intestinal tract than it is if the perforations are lower, because of the relatively cleaner intestinal content of the higher segments, and hence the less likelihood of peritonitis developing. However, high tears are less likely to cause such early and striking symptoms as those in the lower part of the tract, so patients whose tears are high usually come to operation later. Among children who have sustained visceral injury, the younger the child, the more serious the outlook.

In carrying out the surgical treatment, that procedure which can be done most quickly, with the least amount of shock to the patient and trauma to the tissues, should be chosen. The operation should not be prolonged, and a constant check should be kept on the blood pressure, pulse, and respiration of the patient, so that immediate treatment can be undertaken if shock supervenes. Long time-consuming resections should be avoided unless the viability of the injured intestine is questionable.

The abdomen may be opened by an incision through either rectus muscle, to give the best exposure, unless localizing signs are present which indicate the section of the bowel involved. In these cases, the incisions may be placed to facilitate repair.

After the peritoneum has been opened, if active bleeding is present, it is better to bring the intestines outside the abdomen and immediately to control the bleeding. If there is no hemorrhage, it is better to examine the bowel and mesentery minutely, starting at some fixed point such as the ileocecal region, and drawing several inches of bowel out at one time, following up or down the whole intestinal tract. When a perforation of the bowel is found it is better to cover it with a warm, moist sponge and lay it aside until the whole intestine has been examined. Sometimes, resection of a portion of bowel may be necessary because of multiple lesions close together, or because of a damaged blood supply in the mesentery, and if a perforation has been closed and then it is found that resection of the loop containing the closed perforation is necessary, much valuable time has been lost.

The question of drainage is an individual one, and depends on the conditions found at operation. The same principles apply in these cases as in all operations on the abdomen.

The postoperative care is concerned with seeing that the patient is kept comfortable by the use of sedatives, and that the intake of fluid is adequate; fluid may be introduced by the intravenous, subcutaneous or rectal routes. After operation, feeding by mouth may be started with sips of water and the amount and consistency of the ingesta may be increased as the patient



tolerates the increase; gradual progress is made through liquid and soft to a normal diet.

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