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THE X-RAY DIAGNOSIS OF INTESTINAL OBSTRUCTION

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INTRODUCTION

Intestinal obstruction may be defined as that situation in which there is a failure of the passage of the products of digestion along the intestinal tract. Obstruction may be acute or chronic and may result from mechanical interference or from functional changes of a neurogenic or vascular nature.

Mechanical obstruction is divided into two main kinds. In simple mechanical obstruction there is no loss of the blood supply of the involved bowel. In a strangulating obstruction there is a partial or complete occlusion of the arteries or veins supplying the involved segment. A strangulating obstruction is not necessarily gangrenous, but will become so if the cause of the obstruction is not relieved. (2)

The treatment of acute obstruction is somewhat varied. Many surgeons agree that if the condition can be diagnosed early, the patient should be operated on at once and the defect corrected. If a simple mechanical obstruction has gone untreated for over 24 hours it may be necessary to treat him medically for a considerable period of time before confronting him with the stresses of surgery.

Due to the rapid deterioration of fluid and electrolyte balance and to the liberation of toxins, a strangulating obstruction is a surgical emergency. Acute large bowel obstructions frequently perforate early and are thus also surgical emergencies. (19)

The surgeon must, therefore, diagnose the presence of an intestinal obstruction as early as possible and must know whether it involves the

small or large bowel and whether it is simple or strangulating in character.

The diagnosis of an acute obstruction may be simple or difficult. An untreated obstruction seen late can usually be readily diagnosed by the signs and symptoms. It is important, however, to diagnose the condition early and this might present considerable difficulty.

The history and physical findings are the best means of determining the diagnosis. Laboratory studies, other than X-ray are useful but are nonspecific. X-ray studies, however, can be of considerable aid to the surgeon in determining the presence and degree of bowel distention.

The following is an examination of obstruction and the use of X-ray studies in its diagnoses.

ANATOMY OF THE INTESTINAL TRACT

Gross Anatomy.

The small intestine varies considerably in length, ranging from twelve to twenty two feet. Normally the duodenum is about one foot long, the jejunum seven to eight feet, and the ileum ten to twelve feet. (12) The dividing line between jejunum and ileum is not sharp. The jejunum tends to be above the umbilicus and the ileum below. Accurate orientation by the surgeon is difficult in a case of obstruction until the ligament of Treitz and ileocecal valve have been identified. Normally the second, third and fourth portions of the duodenum are retroperitoneal and the remainder of the small intestine intraperitoneal. The mesentery of the intestine is normally closely attached to the posterior abdominal wall. (3)

The anatomic divisions of the colon (cecum, ascending colon, hepatic flexure, transverse colon, splenic flexure, descending colon, and sigmoid colon) are easily identified. Variations in the length and diameter of the colon are not uncommon. The extent of the mesenteric fixation is variable. Frequently the right colon is entirely free on a mesentery. The descending colon is essentially always firmly fixed to the lateral and posterior walls. The rectum becomes intraperitoneal approximately opposite the third sacral vertebra and extends down to the base of the pouch of Douglas. The extraperitoneal rectum extends from the pouch of Douglas to the anus. (12)

Blood Supply.

The duodenum is supplied by a mesenteric arch arising from the superior and inferior pancreaticoduodenal arteries which originate from the gastroduodenal and superior mesenteric arteries respectively. (12) The superior mesenteric artery after sending multiple branches to supply the jejunum and ileum, also usually supplies the right and transverse colon via the iliocolic, right colic and the mid-colic branches. The left colon usually receives blood from the inferior mesenteric by way of the left colic branch to the splenic flexure and descending colon and the sigmoid branches. The terminal portions of the inferior mesenteric, the superior hemorrhoidal, supplies the intraperitoneal rectum. The lowest portion of the rectum depends upon the middle hemorrhoidal from the hypogastric artery, and the inferior hemorrhoidal from the internal pudendal. (12) Variations in the pattern of the blood vessels supplying the colon are common.

The intrinsic blood supply of the small intestine consists of a profuse network of vessels. Anastomoses of the intramural vessels in the wall of the small intestine are common. (12) Thus short loops of the small intestine are able to survive when deprived of their mesenteric blood supply as long as distention is prevented.

The marginal artery provides an excellent anastomotic channel for the colon, so that interruption of the main arterial supply to a section is not necessarily disastrous. However, the marginal vessel is small and is easily obliterated by tension or torsion.

Nervous Innervation.

The intestine is innervated by both the sympathetic and parasympathetic divisions of the nervous system. The parasympathetics run from the dorsal vagal nuclei via the vagi and intrinsic visceral plexuses to terminate around the ganglion cells of Auerbach's myenteric and Meissner's submucous plexuses. (10) They stimulate peristalsis and carry some afferent reflex stimuli.

The sympathetic fibers originate from cells in the spinal cord, traverse the lower five to seven pairs of thoracic white rami, and pass through the sympathetic trunk ganglia and along the splanchnic nerves to end in the preaortic ganglia. Postganglionic fibers leave these ganglia to run with the vagal fibers along the periarterial visceral plexuses and from there to the intestine. (10) The efferent pathways carry fibers that inhibit peristalsis, stimulate secretion, and produce vasoconstriction. (10) The afferent fibers carry reflex stimuli, the feeling of nausea and the pain of distention from hollow viscera.

PATHOLOGY AND PATHOLOGIC PHYSIOLOGY

Mechanical obstruction produces different effects according to the site of obstruction, rate of obstruction, presence or absence of strangulation, length of a strangulated loop, and specific type of obstruction.

The primary response to an acute mechanical obstruction consists of a marked increase in peristaltic activity, especially in the segment just proximal to the obstruction. (3) This may account for the normal bowel movement often noted at the onset.

Edema of the bowel wall then occurs rapidly at the site of the obstruction and may cause a partial occlusion to become complete in a short period of time. The bowel proximal to the obstruction now becomes distended while that distal collapses. The distention results from the accumulation of gases and digestive products combined with a decreased absorptive ability by the gut.

The source of fluids and gas includes swallowed air and liquids, normal digestive secretions and gas formed by intestinal putrefaction. The chief sources are swallowed air and the lack of absorption of normal digestive fluids.

Meanwhile, the increasing intraluminal pressure causes the proximal intestine to dilate. High intraluminal pressures do not result unless there is a closed loop obstruction, because the tract is decompressed by vomiting. Obstruction in the colon often causes pressure to rise to a high level because a competent ileocecal valve results in a closed loop type obstruction. (9)

Distention increases the diameter of the bowel, shortens its length and thins the wall. The edema present increases its weight. The intramural blood vessels are stretched and capillary anastomosis obliterated. Blood flow is thus reduced and stasis occurs, first in the venous and then in the arterial system. Finally hemorrhage into the bowel or mesentery results and the blood supply to the bowel disappears so that gangrene develops. This may be followed by perforation, peritonitis and death. (19)

With strangulation, profuse bleeding sometimes occurs into the bowel lumen, mesentery or peritoneal cavity. This may produce hemorrhagic shock. It is due primarily to occlusion of the venous supply while the arterial blood continues to circulate under pressure and seeks an abnormal outlet.

Peristaltic activity is reduced by the distention. The distended atonic loops may then kink producing multiple points of obstruction. Thus, especially with a low obstruction, a significant or extreme degree of abdominal distention may be produced. The diaphragm may become elevated resulting in pulmonary congestion. Venous pressure may be increased in the lower extremities as well as the bowel wall and the circulation time slowed. This may result in venous stasis, thrombosis and embolism.

Simultaneously, the body fluids are rapidly depleted. Approximately 8,000 cc of fluids are excreted into the intestinal tract daily. (1,14) Secretion may be stimulated and increased in the obstructed bowel. If these secretions can not be reabsorbed, large volumes of fluids containing electrolytes are lost from the intracellular and extracellular

body fluid compartments. Furthermore the effective blood volume falls significantly because of distention of the mesenteric vessels. The edema fluid also contains a large amount of plasma. Thus, there may be sufficient fluid and electrolyte loss to result in extensive biochemical changes.

The absorption of a noxious material has been assumed for many years to be responsible for many of the symptoms of intestinal obstruction. These symptoms include prostration, clouded psyche, a high temperature, a low blood pressure and an elevated pulse rate. It may be that these symptoms can be explained by fluid and salt loss. This is particularly true in simple mechanical obstruction. (3) However, the lethal nature of the unidentified constituents of the dark bloody fluid found in a strangulated obstruction has been shown to contain a hemin or hemoglobin derivative. (13) It is assumed by some workers that these toxic products result from the enzymatic digestion of blood entering the bowel lumen. These products are then able to pass through the gut wall after the wall has been devitalized by bacteria. It is postulated that this occurs in the absence of perforation by a transmural migration and that once they reach the peritoneal cavity they are absorbed into the general circulation. (13)

Mild paralytic ileus is extremely common since it occurs after every abdominal operation. (24) Effective peristalsis usually returns in two to three days, but in the presence of peritonitis tends to persist longer. It is also commonly associated with many other lesions including retroperitoneal hemorrhage; fracture of the vertebrae or ribs; renal colic; pulmonary lesions; torsion of the ovary, testicle or

omentum; diseases of the central nervous system, and severe acute infections.

The fundamental cause appears to be overactivity of the sympathetic nerves. (3) Spinal anesthesia will block the sympathetics and sometimes produces rapid deflation of the distended bowel. Ileus also sometimes occurs after the use of autonomic blocking agents such as hexamethonium. Electrolyte imbalances may also cause ileus. Hypochloremic alkalosis, accompanied by hypokalemia has been shown to produce an ileus that responds to electrolyte correction. (20) Mechanical distention may initiate a paralytic ileus and always perpetuates it. Whatever the cause, when distention occurs, the physiologic effects are the same as those of the distention produced by acute mechanical obstruction.

TYPES AND CAUSES OF OBSTRUCTION

Intestinal obstruction may be acute or chronic. Unless otherwise specified it is assumed to be acute. The term ileus is a synonym for intestinal obstruction. However, it is commonly employed to refer only to paralytic ileus.

The following is a list of the relatively common causes of acute obstruction.

I. Due to mechanical occlusion of the lumen.
   - A. Intrinsic lesions of the intestine and colon.
     1. Congenital defects.
     2. Inflammatory lesions.
     3. Tumors.
     4. Traumatic lesions.
     5. Intussusception.
     6. Radiation strictures.
     7. Endometrioses.
   - B. Obturation obstructions.
     1. Fecal impactions.
     2. Balloons of intestinal tubes.
     3. Gall stones.
   - C. Volvulus.
     1. Primary.
     2. Secondary.
   - D. Extraintestinal or extracolonic lesions.
     1. Adhesions and bands.
     2. Hernias.
     3. Compression by extraintestinal mass.

E. Obstruction secondary to surgical operations.

1. Wound dihescence.

2. Intraperitoneal abscess.

3. Anastomatic edema or stricture.

4. Volvulus.

II. Obstruction with an open lumen.

A. Megacolon.

B. Paralytic ileus.

C. Spastic ileus.

D. Mesenteric thrombosis and embolism.

The relative frequency of the types of obstruction are difficult to ascertain. Of 1,035 consecutive cases of obstruction seen at the Massachusetts General Hospital in the period 1947-1955, obstruction of the colon occured in 26.6% of all cases and in the remainder, the small intestine was involved. Large bowel obstruction was due to cancer in 80% of the cases, 16% were due to diverticulitis and the remaining 4% were due to a large variety of causes. (19)

Fifty two per cent of the small bowel obstructions were due to adhesions, 13.7% were due to carcinomatoses, 6.8% were due to external hernia and the remainder to a variety of causes. (19)

In an earlier series at the same hospital (1920-1929) 44% of all obstructions were due to strangulated external hernias and there was much lower incidence of cancer, both primary and disseminated as carcinomatosis. According to Allen quoting from earlier series, approximately 50% of all small bowel obstructions are due to strangulated

hernias and 40% are due to adhesive bands, with the remaining 10% due to a variety of causes. (1)

Hnatuik reviewed 128 cases of acute small bowel obstructions. This series had occured between 1953 and 1957. He found that 60% of the cases resulted from bands and adhesions, 15.6% from hernias, 11.7% from intussusception and only 2.4% from carcinomatoses. (6)

In a series of 100 cases of obstruction reviewed by Ruckstinat bands and adhesions were again the leading cause. It is of interest that 80% of the patients in the series had a history of prior abdominal surgery. (15)

Thus, it appears that strangulated external hernia was a much more frequent cause of obstruction in earlier series and that neoplasms are becoming a more frequent cause. This might be explained by the fact that hernias are now repaired much earlier than they were in the past. That bands and adhesions are becoming more frequent as a cause of obstruction may reflect that a higher percentage of patients have been subjected to abdominal surgery.

The relative incidence of strangulating obstruction is variably reported. If paralytic ileus is excluded, approximately 85% of obstructive lesions of the colon are strangulating in type or may go on to early perforation. Of the 1,035 cases mentioned above at Massachusetts General Hospital approximately 15% of the obstructions of the small bowel were strangulating in type. (19)

The relative frequency of the different types of obstruction also varies with age. Most obstructions of the colon in children result from congenital megacolon while intussusception, volvulus and strangulated

hernia account for most of those in the small intestine. In older groups, colonic obstruction is usually due to cancer, diverticulitis or volvulus and small bowel obstruction to post operative adhesions, carcinomatoses, strangulated hernia or obturation.

THE RADIOLOGIC DIAGNOSIS OF OBSTRUCTION

As previously stated the X-ray examination is the most important diagnostic procedure in the diagnosis of intestinal obstruction. Wangensteen states it is the only procedure by which reliable information can be obtained concerning the grade and location of intestinal distention and the presence of free air in the peritoneal cavity. (11)

Gas is normally seen in the stomach and colon of the adult. The small bowel ordinarily contains no gas. In patients with pain, however, it is not uncommon to see a small amount of gaseous distention of the small intestine. Should a localization of gas remain constant in a given area one must suspect a mechanical obstruction, devitalized bowel, or abscess. (11)

Except for their two fixed ends, the jejunum and ileum vary considerably in their position within the abdomen. Nevertheless, the jejunal loops tend to be located toward the upper left of the central portion of the abdomen while the ilial loops tend to be lower and further to the right. (7)

The lumen of the ileum is smaller than that of the jejunum. The plicae circularis which are numerous in the proximal jejunum, decrease in number toward the ileum and almost cease below the ileum. The stretched out plicae circularis in the distended jejunum may give rise to a characteristic picture, as shown in the top loop of bowel in Fig. 1. The haustral sacculations of the large intestine which are produced by crescentic folds of the entire wall of the large bowel also gives the

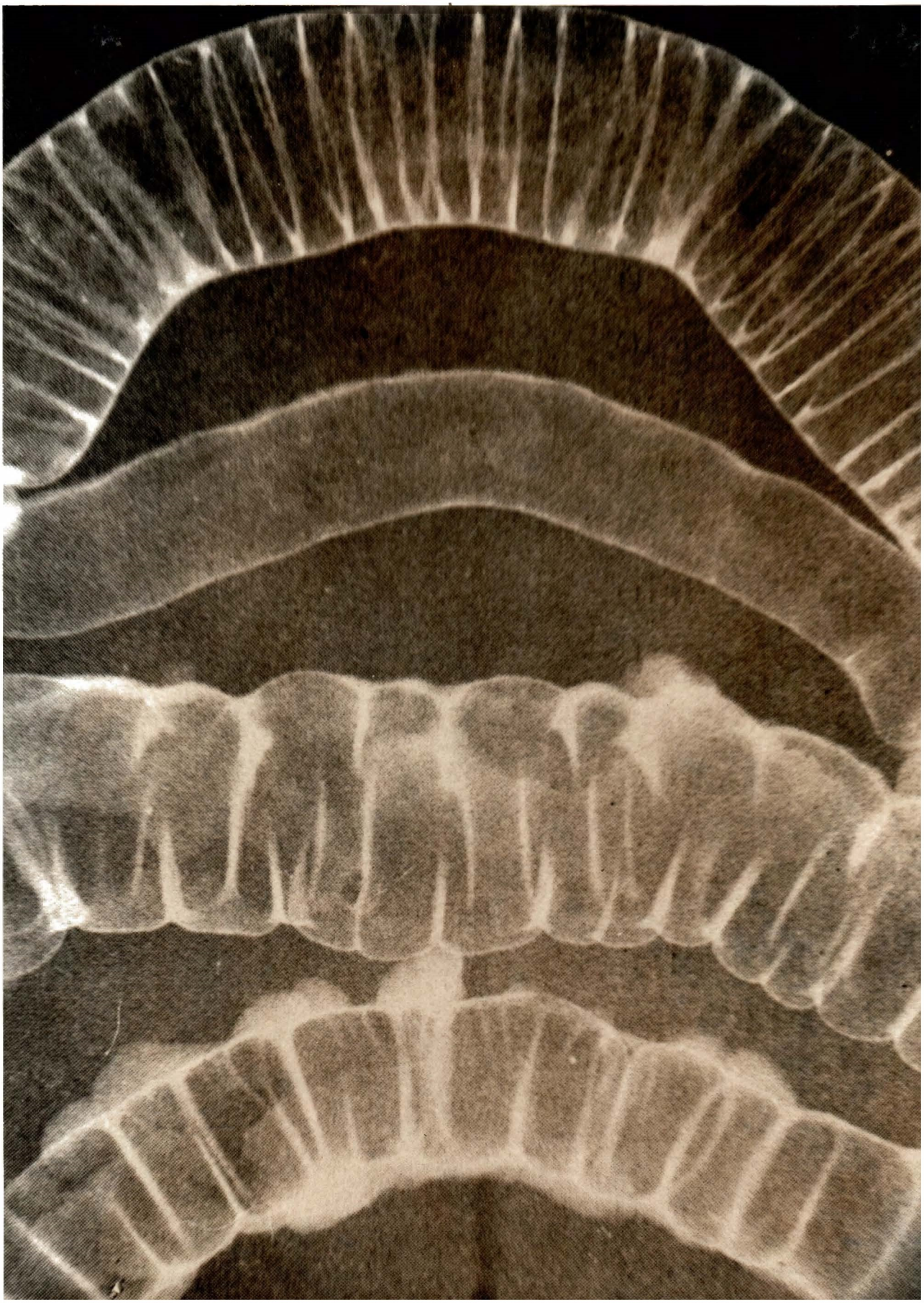

Fig. 1 - from Shanks, S. C., Kerley, P. A Textbook of X-ray Diagnosis Philadelphia: Saunders 2nd ed., pp. 299, 1950.

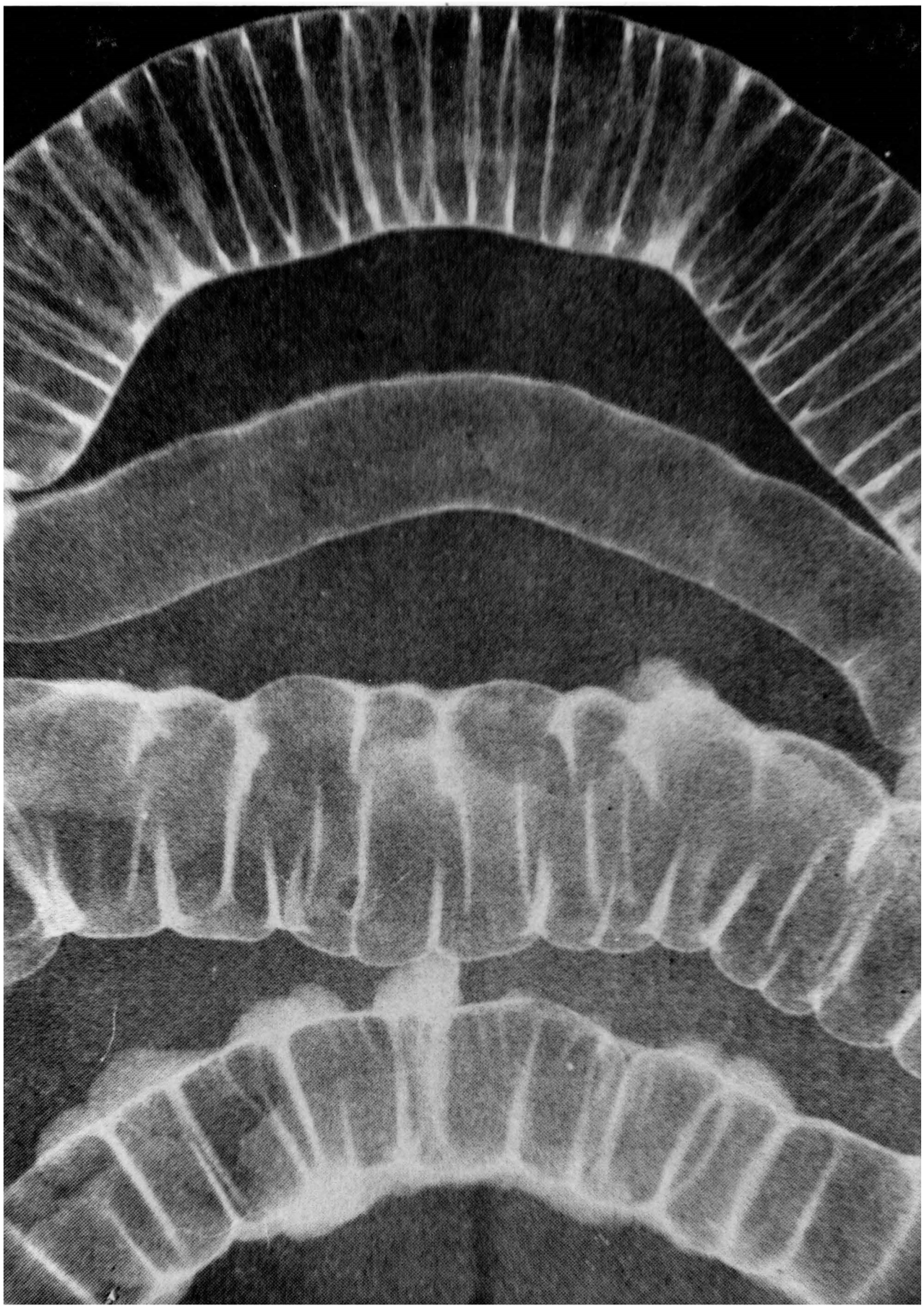

Fig. 1 - from Shanks, S. C., Kerley, P. A Textbook of X-ray Diagnosis Philadelphia: Saunders 2nd ed., pp. 299, 1950.

distended colon a characteristic appearance as may be noted in the two lower loops of Fig. 1. The greatest distinguishing point in differentiating distended large from small bowel is that the indentations involve the entire wall of the large bowel, but only the mucosal, submucosal and occasionally the muscular layer of the small bowel as may again be noted in Fig. 1. Furthermore, the distended large bowel tends to be present in the peripheral rather than central abdomen.

Position of the Patient.

The film made with the patient lying in the supine position gives the best information as to the arrangement of the distended intestinal coils. (8) In this position, the continuity of the intestinal coils can often be traced. Unfortunately, fluid levels are not demonstrable.

Meschan states that the following nine points should be noted in the examination of the recumbent film of the abdomen. (11)

1. The kidney outline and size, shape and contour.
2. The course of the ureters and any abnormalities.
3. The pelvis should be surveyed for the presence of fluid accumulation, soft tissue masses, calcific shadows or abnormal gas patterns.
4. The psoas shadows should be identified and any abnormalities noted.
5. Any abnormalities of the layers of the flank and abdominal wall should be noted.
6. The condition of the bony structure.
7. The gas pattern of the bowel.
8. Any abnormal masses must be identified.

9. The entire abdomen should be studied for the presence of any opaque shadows.

Wangensteen suggests that to prevent the X-ray from being taken too low in the abdomen of a patient suspected of being distended, the lower border of the film should be approximately at the anterior superior spine of the ilium. (18)

The second film to be taken should be an erect film of the abdomen. In the erect position, hollow structures containing both fluid and air will form air fluid levels as may be noted in Fig. 2. Fluid air levels are not necessarily abnormal in the colon but are definitely so in the small intestine. (11) Due to the fixation of the mesentery which extends from the right iliac fossa upwards to the upper pole of the left kidney, and to the inclined lower surface of the liver, distended intestinal loops are pushed towards the left. Gas filled loops tend to move upwards and away from the obstruction while fluid filled coils tend to descend towards the lesser pelvis. Many distended coils lying one above another often show a "step-ladder" arrangement as seen in Fig. 3. Meschan states that the normal maximal distance between contiguous loops of bowel is 3 mm. and that this distance may be visibly increased if a fibrinous exudate is present on the serosal bowel surface. (11) Fluid accumulations may be large while air quantities are small. In this condition a mass containing these two media may not be identifiable in the recumbent position but may still be noted in the erect position.

In the event a pneumoperitoneum is present, the gas may be noted under the diaphragms, or if the lateral decubitus position is used,

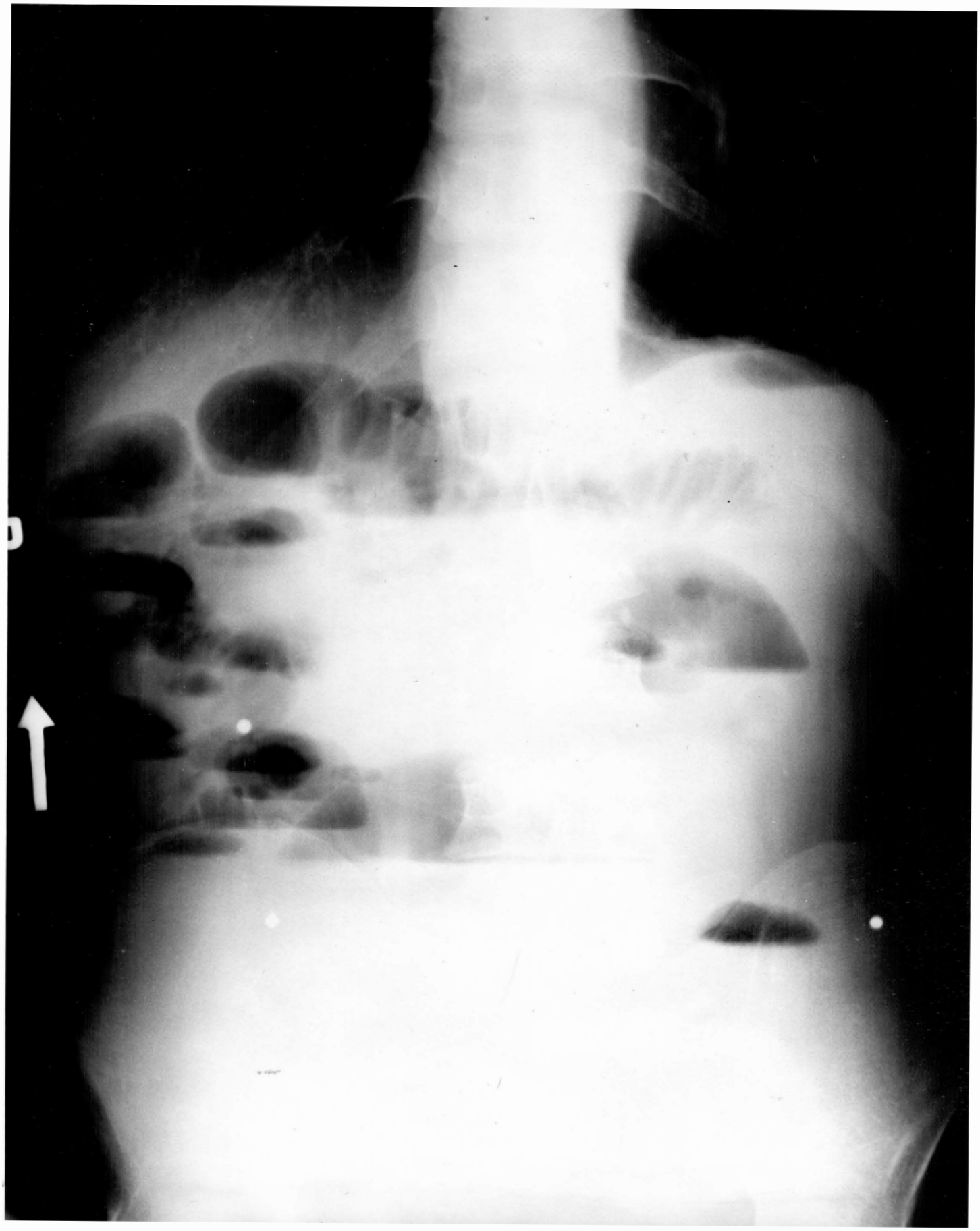

Fig. 2 - Patient R. M. Film No. 160,272 - Nebraska Methodist Hospital.

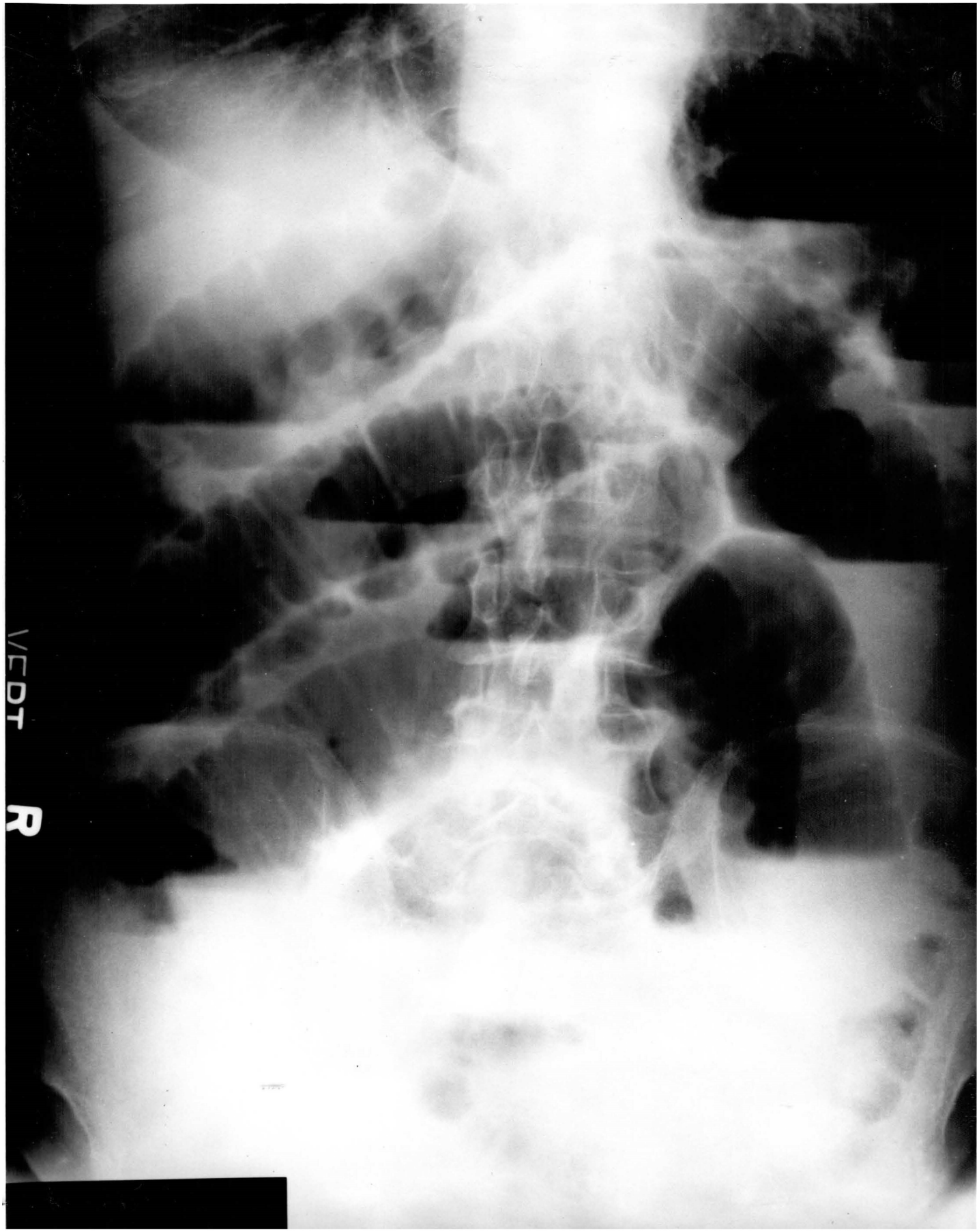

Fig. 3 - Patient H. P. Film No. 140,776 - Nebraska Methodist Hospital.

along the upper abdominal wall. Thus, care should be taken so that the X-ray exposure includes the diaphragms or upper abdominal wall. Furthermore, if possible, the patient should be kept in the erect position for thirty minutes before the exposure is made so that the gas bubbles will have time to float to the top of the peritoneal cavity. (8)

A third film which should be combined with the above studies is a chest film. This will aid in ruling out the presence of any process within the thoracic cage which may result in abdominal symptoms and will further aid in the demonstration of free air under the diaphragm.

The Radiologic Appearance of Major Types of Obstruction.

Frimann-Dahl states that small bowel obstructions may be diagnosed by roentgen examination before the condition can be diagnosed clinically. (5) He further states that one of the most important findings is a persistance of the X-ray findings in the intermediate stage (when the clinical symptoms are subsiding). He states that the following points are characteristic of a simple small bowel obstruction:

1. That the intestinal loops proximal to the obstruction contain gas and fluid.
2. That fluid levels are demonstrable.
3. An increased motility of the intestine.
4. A contracted intestine distal to the obstruction.
5. Fluid in the peritoneal cavity.
6. A delayed passage of the bowel contents proximal to the intestine. (5)

When the above factors are present the distended loops tend to lie one above another and, in the erect films, to give the "step-ladder" appearance. Furthermore, the valvulae conniventes impart a "herring bone pattern" to the distended bowel as previously shown in Fig. 3.

Some cases of obstruction (high) will fail to exhibit distended bowel loops above the obstruction since the gas and fluids are regurgitated to the stomach.

Occasionally a reflex ileus may become superimposed upon a simple obstruction. One must be certain that the distention isn't solely a reflex ileus as occurs frequently with peritonitis.

Both the small and large intestines are usually involved in a reflex ileus. Erect films are more apt to exhibit fluid levels and the levels tend to be larger than in a mechanical obstruction. (18) Frimann-Dahl states that the main findings with a paralytic ileus secondary to peritonitis include the following:

1. Distention with fluid levels in the small and large bowel.
2. Signs of decreased intestinal activity.
3. Free fluid in the peritoneal cavity.
4. Blurring of the "flank stripe."
5. Decreased excursions of the diaphragm.
6. Secondary lung changes. (5)

It is important that the radiologist look for the combination of both mechanical and reflex ileus. At times it may be difficult to determine if one is dealing with the small or large bowel. An emergency examination with a barium enema will differentiate the two types of bowel.

The ileocecal valve is sufficiently competent, in the majority of patients, to block the backflow of colonic contents into the small bowel. Thus a large bowel obstruction results in the distention of large bowel above the obstruction and an empty colon below it as may be noted in Fig. 4. The small bowel usually fails to become distended for a considerable length of time. Should the colon become severely distended, the haustral markings may be lost, and the distended loops may extend centrally away from their usual peripheral location.

As previously stated, a strangulated obstruction is the most dangerous type of obstruction. Unfortunately, cases of complete strangulation frequently show few or no X-ray findings and are the most difficult type of obstruction to diagnose. A strangulated loop of bowel collects gas only if it is partially obstructed. If completely obstructed, it becomes distended with fluid, and is represented only as an opaque mass. No good explanation has been given as to why the bowel loops proximal to the strangulated loop frequently fail to become distended from swallowed air until relatively late.

Frimann-Dahl lists the following X-ray findings as suggestive of a strangulating obstruction: (5)

1. Few visible gas bubbles in the bowel.
2. Often small fluid levels.
3. A tumor-like opacity.
4. Little gas in the colon and sometimes also in the cecum and ascending colon.
5. Abundant peritoneal fluid.
6. Decreased excursions of the diaphragms.

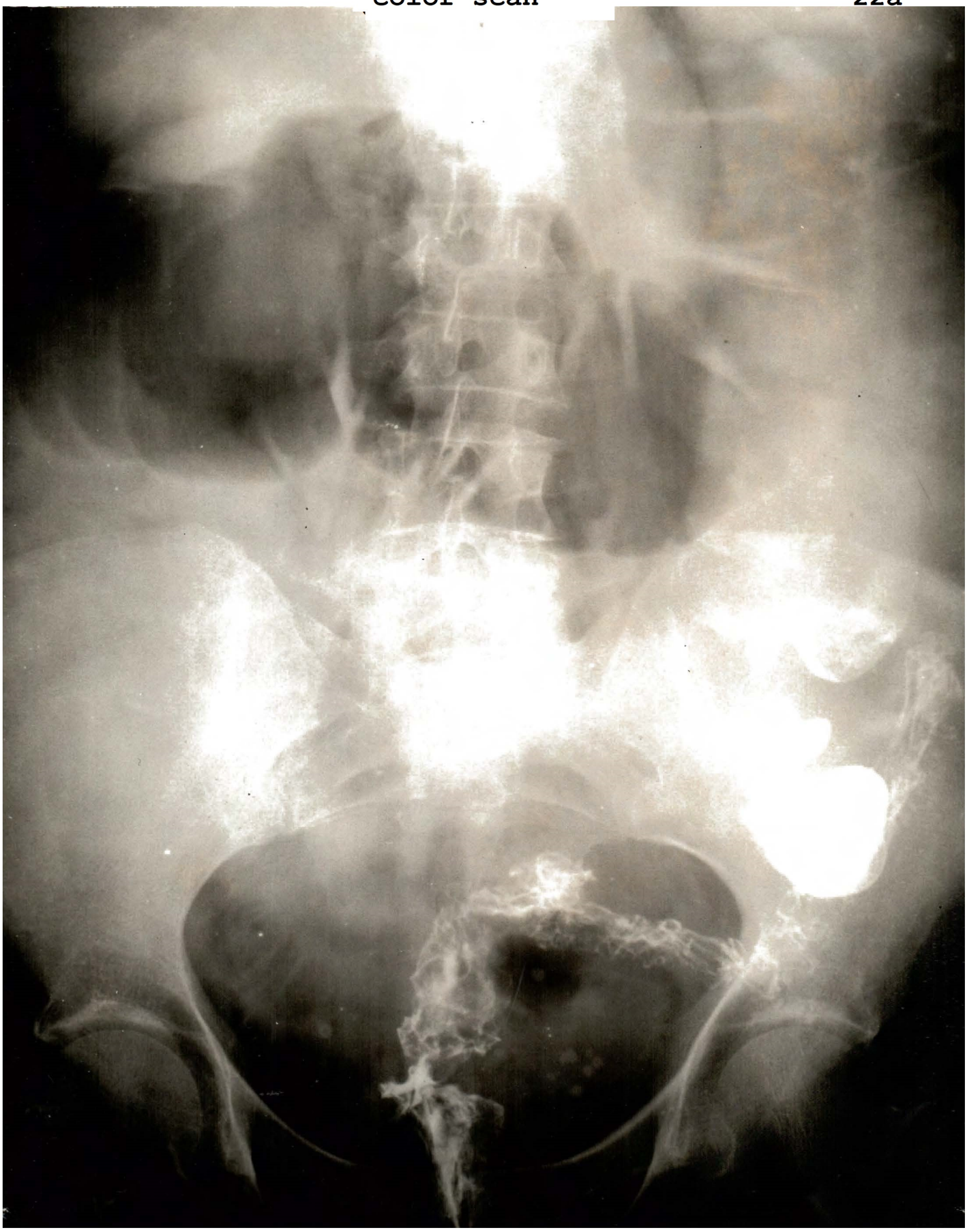

Fig. 4 - Patient C. G. Film No. 144,541 - Nebraska Methodist Hospital.

Fig. 4 - Patient C. G. Film No. 144,541 - Nebraska Methodist Hospital.

7. Displacement by the fluid filled loops of other organs.
8. The patient is seen early for X-ray examination because of pain.

Thus, with X-ray studies of suspected strangulated obstruction one must be especially certain to have a film made in the erect position since the fluid filled loops are most readily so noted, and to examine the film for any space occupying mass. Of course rather than exhausting the patient by making him sit or stand, the films can be made in the lateral decubital position. (16)

The Major Types of Obstructing Lesions - The X-Ray Appearance.

Bands and adhesions are infrequently found unless there is a prior history of abdominal surgery. The regions most apt to contain adhesions are the appendiceal region, pelvic region and the site of a prior cholecystectomy. (15) If obstruction occurs it may be a simple obstruction or strangulating. The appearance is then that of a distended small bowel with fluid levels or occasionally with a complete strangulation - a space occupying mass.

Carcinomatosis may involve either the small or large intestine or both. However, probably because of its smaller lumen, the small intestine is the most frequently obstructed. The result is a simple obstruction, which may be partial, with fluid waves and gasseous distention.

The external hernias several decades ago were the leading cause of intestinal obstruction. Femoral and umbilical hernias are the most apt to result in a strangulation. (18) The appearance is that of a mechanical obstruction. The gas and fluid filled loop may be visualized "outside of the body" in the hernia pocket.

By far the most frequent cause of large bowel obstructions is carcinoma of the colon. (17) Obstruction occuring below the splenic flexure is usually heralded by acute proximal colonic distention while the distal colon is collapsed. With a competent ileocecal valve, there may be no distention of the small bowel until late. A carcinoma of the cecum tends to block the iliocecal valve and one is then presented with the picture of a simple small bowel obstruction and a non-distended colon. Carcinomas of the ascending colon and hepatic flexure infrequently cause obstruction, but if they do, it is an acute obstruction with distention of the proximal colon.

In the series previously mentioned from Massachusetts General Hospital, 16% of large bowel obstructions resulted from diverticuli. Diverticuli may occur in any portion of the colon or small intestine but the vast majority are found in the sigmoid. When diverticulitis causes obstruction, it most frequently produces a chronic partial obstruction, with slow distention of the proximal colon. If adhesions form about the diverticuli, a small bowel obstruction may occur secondary to these bands and adhesions.

The Reliability of the X-Ray Diagnosis of Obstruction.

Most authorities agree that the X-ray diagnosis of obstruction is correct in approximately 90% of cases. Sloan (16) in a recent evaluation found that obstruction was correctly ruled out by X-ray in 243 of 264 suspected cases (92%). The diagnosis of obstruction was correctly made in 96 out of 108 suspected cases (89%). However, when the attempt was made to diagnose the type of obstruction the accuracy decreased.

Forty six out of 63 cases were correctly diagnosed as mechanical in type (78%). Only 18 out of 37 cases were correctly diagnosed as paralytic. Thus, in this series the diagnosis of obstruction was correct in the large majority of patients. Despite the increasing error when the type of obstruction was diagnosed, however, the radiologist was still frequently able to make the correct evaluation.

A REVIEW OF 16 CASES OF ACUTE OBSTRUCTION FROM NEBRASKA METHODIST HOSPITAL

Seventeen cases of acute intestinal obstruction were reviewed from the files of Nebraska Methodist Hospital of Omaha. Sixteen of these cases went to surgery within 24 hours of the time that abdominal films were made. The seventeenth patient who was suffering from an acute distention of the small bowel underwent a spontaneous resolution of the obstruction following the application of a long intestinal suction tube.

The following is a list of the patients including the pre-surgical radiologic diagnoses and the findings at surgery. The accompanying figure is the film number.

1. H. G. 144,541
   X-ray diagnosis: neoplasm of the descending colon and distention of the proximal large bowel.
   Surgical findings: same.

2. E. H. 125,729
   X-ray diagnosis: Distended colon proximal to an annular constriction of the sigmoid colon due to neoplasm or diverticulitis.
   Surgical findings: same due to Ca of the sigmoid.

3. C. N. 138,382
   X-ray diagnosis: Distention of ascending and transverse colon with an annular constriction of the sigmoid flexure due to neoplasm or diverticulitis.
   Surgical findings: same due to Ca of the sigmoid.

4. I. M. 125,320
   X - ray diagnosis: Distention of the colon proximal to a constriction at the sigmoid colon. Probably neoplasm or diverticulitis.
   Surgical: Obstruction of colon secondary to carcinoma of the cervix which had spread to involve the sigmoid.

5. C. C. 140,323
   X-ray: Volvulus of the cecum.
   Surgical findings: Volvulus of the cecum.

Barium enema studies were used in the above five patients and the radiologist was able in each case to correctly diagnose the presence, type and cause of the obstruction. There were three additional cases of large bowel obstruction in the series. The diagnoses were made in the following cases in the absence of contrast media.

6. C. C. 140,323
   X-ray: Distention of the large and small bowel secondary to a fecal impaction in the sigmoid colon.
   Surgical: same.

7. R. W. 149,552
   X-ray: Distention of the small and large bowel proximal to the transverse colon secondary to large bowel and possibly small bowel obstruction.
   Surgical: Same with multiple adhesive bands obstructing the transverse colon and small intestine.

8. E. G. 140,801
   X-ray: Ileus of the large bowel.
   Surgical: Same secondary to a ureteral stone.

In each of these three cases, the radiologist correctly diagnosed the presence and type of obstruction. In case No. 6, he also correctly diagnosed the cause.

There were eight cases of obstruction in the series primarily involving the small bowel.

9. H. R. 128,355
   X-ray: ileus of the colon.
   Surgery: ileus of the colon secondary to a strangulated loop of ileum which had passed through a defect in the broad ligament.

10. H. C. 128,351
   X-ray: Distention of the small bowel proximal to an obstruction of the ileum.
   Surgery: A large loop of small ileum bowel had become strangulated by an adhesive band.

These were two of the four greatest surgical emergencies in the series. In these two cases, the radiologist was able to diagnose the presence of the obstruction and its level but in both cases failed to diagnose the presence of a strangulated loop of bowel.

11. H. P. 140,849
X-ray: Distention of the small bowel secondary to an obstruction of the lower ileum. A loop of ileum has the appearance of being strangulated.

Surgical: Gangrenous ileum (7 cm) secondary to a mesenteric infarct.

12. A. U. 137,602
X-ray: Distention of the small bowel secondary to obstruction of the ileum which has the radiologic appearance of a surgical emergency.

Surgery: Mesenteric thrombosis with 3-4 feet of gangrenous ileum.

The above two cases represent surgical emergencies in which the radiologist was able to recognize that an acute emergency was present but failed to correctly diagnose the cause of the emergency.

13. E. D. 140,745
X-ray: Reflex ileus of the small bowel probably secondary to an appendecteal abscess.

Surgery: same.

14. J. R. 159,100
X-ray: Obstruction of the efferent loop of jejunum of a gastroenterostomy (seen with a barium swallow).

Surgical: Same.

The radiologist correctly diagnosed the above two cases as to the presence, type and cause of obstruction.

15. F. B. 138,633
X-ray: Marked distention of the small bowel.

Surgery: Distention of the small bowel secondary to the herniation of a loop of ileum into an evisceration.

16. J. S. 110,955
X-ray: Distention of the small bowel and displacement of the bowel loops and stomach. Probably secondary to inflammation of the mesentery.

Surgery: Distention of the small bowel secondary to displacement by the inflammed transverse colon. The colon had become inflammed secondary to a ruptured Meckel's diverticulum.

In these two cases the presence and type of obstruction were correctly diagnosed but not the cause.

Thus, in this short series the radiologist correctly diagnosed the presence of obstruction in all 16 cases. He also correctly diagnosed the predominant type of obstruction in all 16 cases. Furthermore, he was able to correctly suggest the cause of obstruction in 8 of the 16 cases, although six of the eight involved obstruction of the large bowel and the use of radio-opaque dye. However, in the two cases of mechanical strangulation he failed to note the presence of a strangulated loop of bowel. To the radiologists credit it should be added that he was able to warn the surgeon of the presence of a surgical emergency in the two cases of mesenteric thrombosis and infarction.

Only three of the cases in this series could be directly attributed to bands and adhesions. Four of the cases resulted from carcinomas. The remainder resulted from a variety of causes.

SUMMARY

Intestinal obstruction, if uncorrected, may rapidly lead to death particularly through the systemic manifestations of fluid losses and electrolyte imbalances. Strangulated obstructions present an increased danger because of the absorption of toxins which are probably hemin derivatives.

Large bowel obstructions frequently behave like a closed loop obstruction due to the competence of the ileocecal valve. With the resulting marked distention, there may be early deterioration of the bowel wall followed by perforation.

Approximately 75% of mechanical obstructions involve the small bowel. Approximately 20% of these are strangulating in type. Of the 25% involving the large bowel, 85% may lead to early perforation.

Although numerous sources state that exterior strangulated hernia is the leading cuase of small bowel obstruction, this is no longer true. Apparently due to the increased proportion of the population who have undergone surgery (abdominal) and as a result have developed intraperitoneal adhesions, bands and adhesions are now the leading cause. Another factor may be that a larger percentage of the population are now having hernias repaired early. Due to the rising life expectation of the population carcinomatoses has been a relatively frequently cause of obstruction of the small bowel.

The bulk of large intestine mechanical obstructions result from carcinoma of the colon. Most of the remaining cases will be found to result from diverticulitis.

The X-ray remains the best non-surgical procedure for determining the presence, degree and location of abdominal distention.

Due to the possible rapid deterioration of the patient in the presence of a strangulated obstruction or perforation of the bowel, it is most important for the radiologist to be able to diagnose strangulated obstruction and large bowel obstruction early.

Gas filled loops of intestine can be readily identified by X-ray. In the presence of simple mechanical obstruction and of ileus, the intestine almost invariably becomes relatively rapidly distended by swallowed air, and the distended loops can be visualized within twelve hours, radiologically. Thus, large bowel obstructions can usually be identified early.

Strangulated obstructions cannot become distended by air unless the proximal loop is only partially obstructed. Instead they tend to be distended by fluid due to an increased production and a decreased absorption of secretions. Thus, strangulated obstructions are usually difficult to identify except as a moderately opaque tumor-like mass.

In suspected perforation, upright films often reveal the presence of free air under the diaphragm. The patient should be left in an upright position for at least 30 minutes prior to filming to permit the air bubbles to float to the diaphragm and coalesce to form a visible aggregation of gas.

The X-ray diagnoses can be expected to be approximately 90% correct in diagnosing the presence of bowel obstruction. The accuracy of diagnosis falls when an attempt is made to diagnose the type of

obstruction but is still significantly accurate to be of considerable aid to the surgeon in determining the type and cause of the obstruction.

Of the 16 cases reviewed at Nebraska Methodist Hospital who were obstructed and whose radiologic diagnoses were proven at surgery, the radiologic diagnoses were invariably correct as to the presence and type of predominant obstruction. Unfortunately, in the only two cases of strangulation present in the series, the strangulated loop of bowel was missed in both cases.

In nearly half of the 16 cases the radiologist was able to diagnose the cause of the obstruction.

CONCLUSIONS

1. Intestinal obstruction may rapidly lead to death.
2. Strangulating obstructions and acute obstructions of the large bowel are surgical emergencies.
3. The X-ray is the best non-surgical procedure for determing the presence and degree of intestinal distention.
4. The over-all accuracy of the X-ray diagnosis is approximately 90%.
5. The radiologist can diagnose the presence of a completely strangulated bowel loop with only fair accuracy.

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