ROENTGEN DIAGNOSIS of ABDOMINAL TUMORS in CHILDHOOD

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SHOWING HOW: **Relatively** simple radiographic procedures, adaptable to the majority of hospitals and even private offices, may aid in leading to a MORE SPECIFIC DIAGNOSIS of many of the abdominal tumors encountered in infants and children.

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C.M.N., Jr.
A.R.M.
L.G.R.

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ROENTGEN DIAGNOSIS OF ABDOMINAL TUMORS IN CHILDHOOD

Chapter I

Introduction

SINCE it is the prime function of a physician to attempt to heal the sick, and since an accurate diagnosis aids in this function, there are many physicians who believe that every effort should be extended to make a correct diagnosis in every patient. On the other hand, to some this idea almost appears to be a fetish when extensive study is performed in an apparently moribund subject.

All methods of diagnosis, including history, physical examination, roentgen studies, chemical tests and histologic studies, are subject to some degree of error. The effort, therefore, to obtain an exact histopathologic diagnosis by means of surgical exploration is not uniformly successful. Error may occur if the region of the principal disease process is not accurately located, for the specimens thus obtained for histopathologic study might not be truly representative. There are, of course, other sources of error in surgical exploration and histologic study.

Quite often an accurate clinical diagnosis can be made by a limited clinical approach utilizing the history, physical examination and relatively simple laboratory procedures. However, it has been suggested that the physical manipulation incurred by palpation of tumors by several observers may lead to metastasis (13), and it is suggested that other means, including surgical exploration, may be preferable in attempting to elicit an exact diagnosis in patients with tumors.

In the case of abdominal masses occurring in childhood there is a definite tendency among physicians to suggest exploratory laparotomy after palpating a mass with little more than a simple anteroposterior roentgenogram of the abdomen to locate the general region involved. It is often argued that a specific diagnosis cannot be made by any means before laparotomy and that much time and money are saved by proceeding rapidly to surgical exploration. Because of this attitude the number of cases accurately diagnosed before laparotomy has tended to be small.

There is much to be said for making an attempt to make a diagnosis before surgery. There are few surgeons who would not prefer knowing as specifically as possible the preoperative diagnosis, if this can be established by relatively safe means. We recently observed a patient in whom the exploring surgeon failed to find an abscess in the abdomen. Upon being called to the operating room the roentgenologist demonstrated upon simple anteroposterior and lateral roentgenograms of the abdomen the exact location of the abscess, which was then promptly drained.

There are patients with palpable abdominal masses in whom surgery is not necessary or may even be dangerous. If the palpated mass can be reasonably shown to be an enlarged spleen there is little chance that the patient will receive benefit from surgery. In conditions such as hydrometrocolpos surgery is not needed for diagnosis or treatment. In rare cases such as the anterior sacral meningocele the operative results are poor, and surgery must be planned carefully if any permanent benefit is to be obtained. Postoperative mortality is greatly decreased in patients with choledochal cysts if the diagnosis is suspected before operation (57).

Furthermore, the making of a correct preoperative diagnosis may appear to be of academic interest only in one era of medical thinking, whereas at a later date accurate diagnosis in the same medical domain may be of paramount interest. The field of congenital cardiac disease illustrates this very clearly. As recently as 1936, the following remark was overheard at a medical meeting in which the late Maude Abbott participated: "Poor Maude Abbott, she has spent her life studying a group of conditions about which nothing can be done" (68).

We believe that the diagnosis of a large number of abdominal masses in childhood may be established by relatively simple clinical and roentgenologic methods. If this is accomplished with a minimum of manipulation and expenditure of time, it seems reasonable that very little harm, and often a lot of good, will ensue in handling of these patients.

Historical Data

Within a few years after Roentgen's discovery of x-rays attempts were being made to opacify the gastrointestinal tract and to this time such studies have been utilized in diagnosing lesions in the alimentary canal. The attempts to diagnose extra-alimentary lesions in the abdomen have been slower in developing. Most of the articles in the medical literature have dealt with extra-alimentary masses in adults. Many of the principles apply to a large extent in children.

In 1923 Dickson (20) described displacements of the barium-filled stomach, duodenum and colon produced by masses in the liver, gallbladder, pancreas, spleen and kidney. He found other retroperitoneal masses difficult to locate. Stereoscopic views were used to determine anterior and posterior location. Laurell had already described the presence of teeth or bone in dermoid cysts in 1922, and in 1925 he also observed that a dermoid cyst may cast a radiolucent shadow because of its high fat content (43).

In 1928 Brown initiated a small series of essays (8-10) on the differential diagnosis of abdominal masses by the roentgen method. He utilized principally the barium meal and enema, and emphasized the importance of the lateral view. He also called attention to displacement of the duodenojejunal flexure by pancreatic (retroperitoneal) masses, noting that enlarged retroperitoneal lymph nodes seldom affect the flexure.

In 1931 Butler and Ritvo (11) used plain roentgenograms and barium studies in several projections to study extra-alimentary masses. They divided the abdomen into four regions, *viz.*, left upper quadrant, right upper quadrant, epigastrium and hypochondrium, and pelvis and lower abdomen, and then described diagnostic features of the masses commonly seen in each region.

Using a similar method Wiese and Larimore in 1932 (76) reported findings in 126 intra-abdominal extra-alimentary masses.

In 1933 Rigler (51) divided extra-alimentary abdominal masses into four groups thusly:

1. Upper abdominal, intraperitoneal (spleen, liver and gallbladder).
2. Pancreatic tumors, cysts and retroperitoneal upper abdominal glands.
3. Retroperitoneal masses, including kidneys.
4. Masses of pelvic origin.

At that time thorium dioxide (Thorotrast) had already been used to opacify the liver and spleen, but Rigler showed that hepatic and splenic enlargements could be accurately located more simply by their effects on the alimentary tract. He also indicated the value of the lateral view in differentiating omental from mesenteric cysts, and emphasized the use of intravenous urography and retrograde pyelography in the study of retroperitoneal masses.

Several years later Shambaugh (58) noted that although an enlarged spleen occasionally displaces the left kidney, such renal displacement usually indicates an extraperitoneal mass.

In 1939, Rose (53) reviewed the importance of various calcareous shadows found on roentgenograms of the abdomen. This was followed in 1941 by another similar review by McCullough and Sutherland (46) who described the various calcareous shadows in various regions of the abdomen.

In 1940 Case (16) reviewed the roentgenographic findings in pancreatic disease. Several papers have appeared over the last three decades describing the findings in individual organ enlargements or in individual mass lesions. In 1946 Garcia Capurro and Piaggio Blanco (14) published an extensive monograph, in Spanish, on the topographic approach to localization of abdominal masses in adults. More recently Wilson (79) summarized considerable information concerning abdominal cysts in infants and children.

Several basic principles established in the above and other writings have been utilized in forming a relatively simple approach to the roentgen diagnosis of abdominal masses in infants and children.

Chapter II

Anatomic and Embryologic Notes

IN ITS course of development the digestive tube in the human embryo traverses the coelomic cavity suspended from the posterior abdominal wall by a dorsal mesentery. The dorsal mesentery extends along the entire length of the alimentary tube. The anterior mesentery, attaching the tube to the anterior abdominal wall, exists only in its upper portion and stops at the level of the umbilicus (about the middle of the second portion of duodenum). The peritoneal membrane, lining the walls of the peritoneal cavity, extends along the mesenteries and covers the external surface of the gut. This arrangement persists in quadrupeds.

In the human embryo, however, multiple deviations from this simple ar-

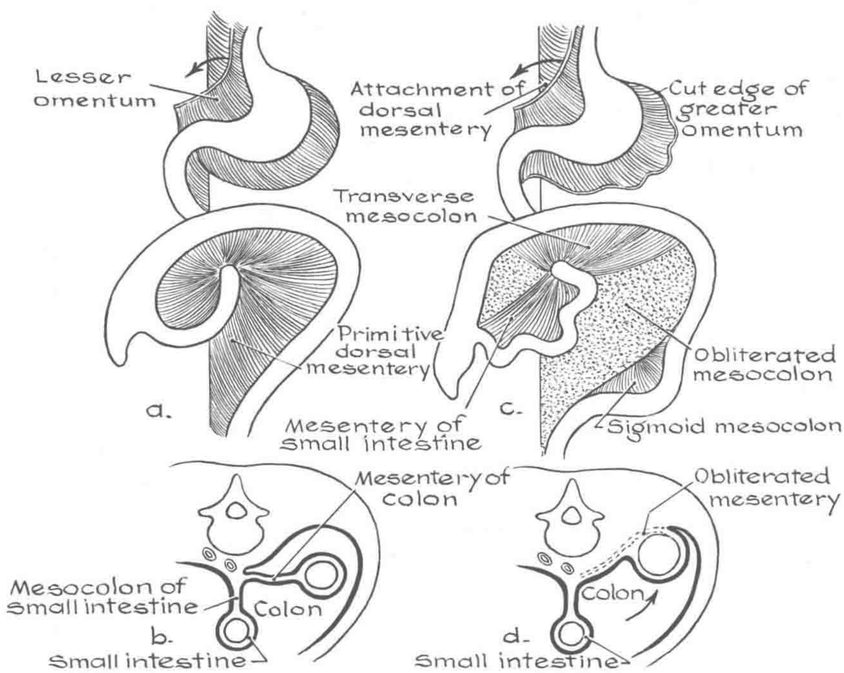

FIGURE 1. The development of secondary attachments and obliteration of the colonic mesentery. (A) The cone-shaped mesentery before the secondary attachments take place. (B) A cross section at the same stage. (C) Lines of secondary attachment of the mesentery of the colon. Surfaces of obliterated mesocolon and residual mesentery are demonstrated in schematic fashion. (D) Cross section at the same stage.

rangement occur. At first the stomach has a right and left wall. As the liver grows in size rapidly, it brings about a rotation of the stomach to the right. The portion of the anterior mesentery that initially connected the anterior aspect of the liver to the anterior abdominal wall becomes the falciform ligament of the liver. The remainder of the anterior mesentery forms the gastrohepatic and hepatoduodenal ligaments. These are also designed as the lesser omentum. The former left surface of the stomach

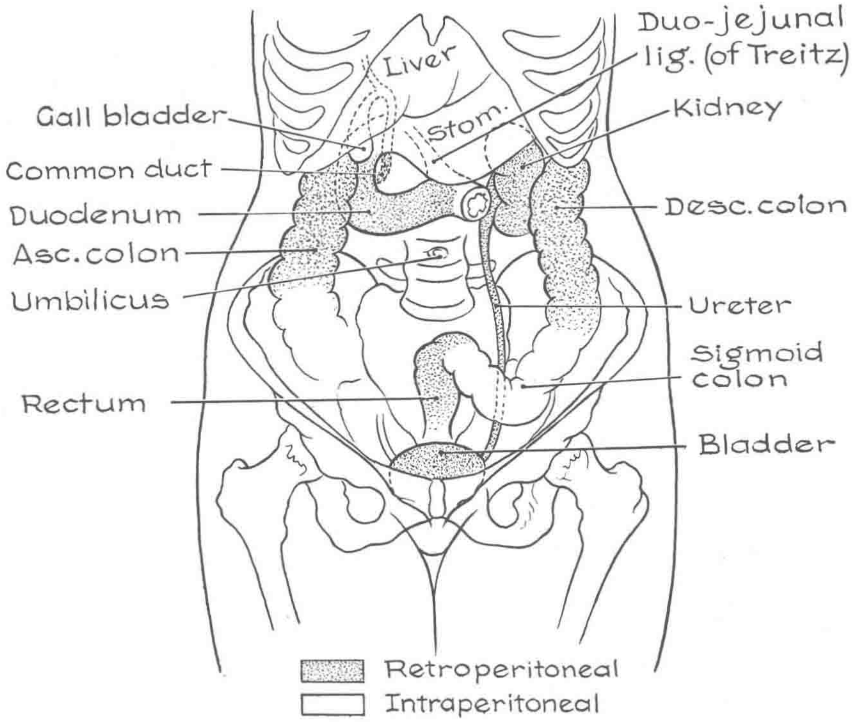

FIGURE 2. A schematic presentation of landmarks for orientation as to whether abdominal masses are intra or extraperitoneal. The bowel that is suspended on a mesentery within the peritoneal cavity is marked "intraperitoneal" for orientation purposes.

becomes the anterior, and the posterior border forms the greater curvature. Even before the stomach rotates, a small cavity begins to form in the dorsal mesentery, or mesogastrium, and this forms the lesser sac. As the mesogastrium grows after rotation, a part of it becomes the greater omentum.

In the third month the lesser sac starts to make secondary attachments, and fuses with the dorsal body wall. The pancreas, which has extended into the dorsal leaf of the lesser sac, now becomes fixed behind it. A portion of the greater omentum also fuses with the upper surface of the transverse mesocolon. The mesentery keeps pace with the growth of the intestinal tube along its attachment to it. The part of the mesentery that is attached to the abdominal wall shares that structure's rate of growth, the result being a fan-shaped mesentery.

As the intestine continues to grow out of proportion to the growth of the abdominal cavity, it leaves the cavity at about seven weeks and is carried into the umbilical cord. During the return of the loops of bowel into the abdominal cavity, which occurs about three weeks later, rotation of the cecum is completed. The cecum and transverse colon are carried in front of the duodenum, with the cecum coming to rest in the right abdomen after it has advanced through the left abdomen and crossed to the right behind the omentum. The cecum and ascending colon thus lie to the right of the small intestine. The rotation of the bowel results in a rotation of the mesentery which is attached to it. The axis of rotation is around the origin of the superior mesenteric artery, and from this point the fan-shaped mesentery spreads into a broad cone (Fig. 1A).

About the middle of the fourth month, the mesentery ceases being a free sheet and secondary attachments occur as illustrated in Figure 1E. The mesentery of the duodenum (the mesoduodenum), the mesentery of the ascending colon, and the descending colon attach to the posterior abdominal wall, become obliterated, and form part of the posterior parietal peritoneum. The pancreas, which originally developed in the posterior mesoduodenum, remains behind the obliterated mesentery and assumes

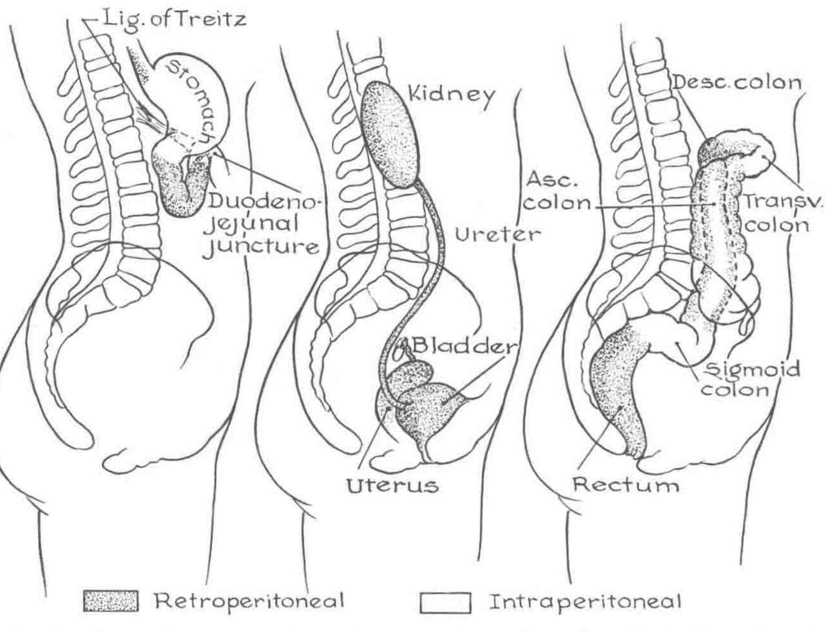

FIGURE 3. A schematic presentation of extraperitoneal landmarks in lateral projection. As in Figure 2 bowel suspended on a mesentery is depicted as intraperitoneal for orientation purposes.

a fixed retroperitoneal position. As seen in Figure 1C, the residual colonic mesentery is limited to the transverse mesocolon and the mesosigmoid; the mesorectum also is obliterated. The small bowel mesentery remains free from the dudenojejunal juncture to the end of the terminal ileum, its root being along an oblique line on the posterior surface, extending from the origin of the superior mesenteric artery to the ileocecal valve. From this

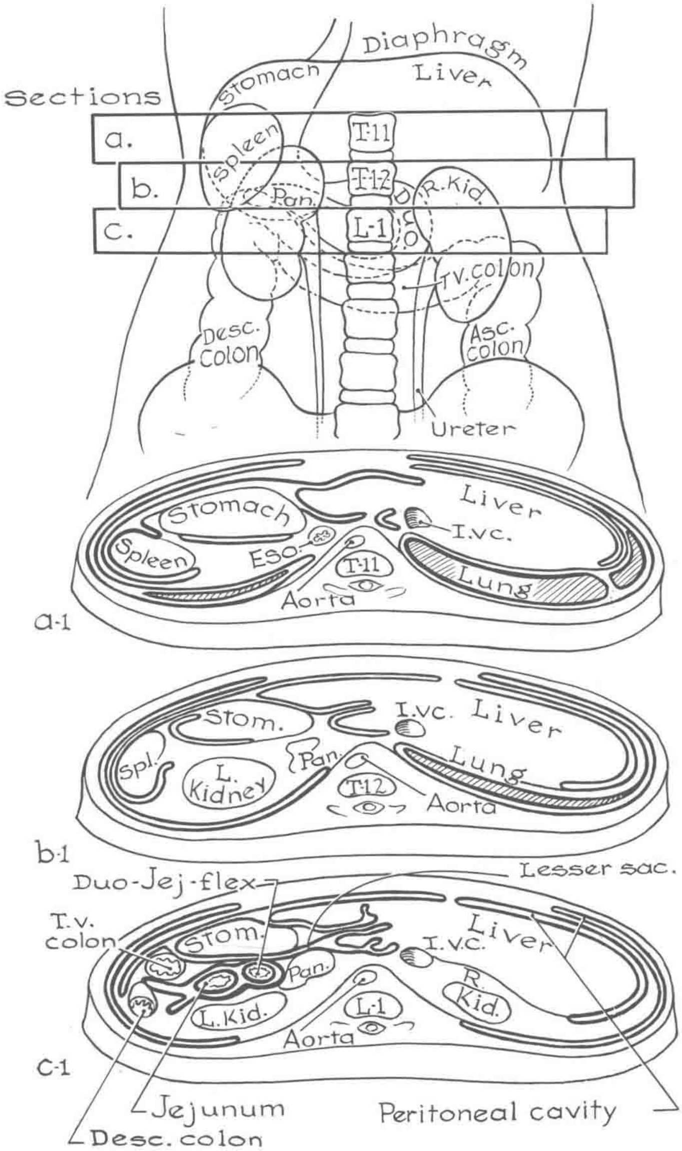

FIGURE 4. A schematic presentation of relationships of organs in transverse section at levels a, b, and c in the upper abdomen. (From posterior view.)