Anatomic Patterns of Ga-67 Distribution in Localized and Diffuse Peritoneal Inflammation: Case Report

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Radiogallium imaging may be useful in identifying localized and diffuse peritoneal disease. The posterior peritoneal reflections can be delineated, providing further anatomical differentiation of disease processes in the peritoneum. This may allow separation of peritoneal from retroperitoneal disorders.

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The purpose of this paper is to present several cases that document the appearance of the Ga-67 citrate scan in peritonitis. Some of these cases show that the main posterior reflections of the mesentery may be delineated on the scan, and emphasize that analysis of the image can supply valuable information concerning the localization of the disease process, including differentiation between peritoneal and retroperitoneal processes.

CASE REPORTS

Case 1. A 23-year-old woman presented with a 1-day history of abdominal pain and vomiting. Five years earlier she had an ileocolectomy for Crohn's disease. Physical examination was negative (T 39.4°C; P 110; BP 120/60; WBC 14,000). The patient's abdomen soon became distended. A barium study revealed small-bowel obstruction, and the patient was treated with a long tube. A scan with Ga-67 citrate was performed because of continuing leukocytosis and febrile reaction (Fig. 1). The diagnosis of diffuse peritonitis was suggested and was proven at operation, where an ileal perforation was found. The peritoneal aspirate was positive for *E. coli*. Despite antibiotic treatment, the patient remained febrile. A second Ga-67 citrate study suggested a localized inflammatory collection (Fig. 2). At a second operation, this was found to be an abscess, which was successfully drained.

FIG. 1. Anterior rectilinear scan (Case 1) showing intense hepatic and more diffuse left-sided infracolic accumulation of Ga-67. Patient had diffuse peritonitis, confirmed at operation. Oblique line crossing the image (arrow) is assumed to be mesenteric root.

Case 2. A 51-year-old woman presented with a low-grade fever, 10 mo after a jejunal-ileal bypass for morbid obesity. Initial physical examination revealed T 38.9°C; P 90; BP 120/60; initial WBC 17,000. A blood culture grew gram-positive cocci. A Ga-67 citrate scan (Fig. 3) revealed diffuse uptake, and an anastomotic leak was assumed to be present. A second surgical procedure was avoided as too hazardous, and the patient became afebrile after 1 mo of antibiotic treatment. The WBC dropped to 8,700. One year later she presented again with a mild febrile reaction. A Ga-67 citrate scan was similar in appearance to her previous scan. At operation the surgical anastomoses were intact and no peritoneal fluid or pus was present. Multiple adhesions

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FIG. 2. Repeat anterior Ga-67 image in Case 1. This indicated a localized inflammatory process, which was confirmed to be an abscess at surgical re-exploration. The liver, spine, and sacroiliac joints are also visualized.

FIG. 3. Anterior Ga-67 scan in Case 2. There is diffuse left-sided infracolic accumulation in abdomen, which was presumed to be due to leakage of a jejunal–ileal bypass. One year later, with a similar scan, surgery demonstrated only multiple adhesions.

were found. The patient's postoperative course was uneventful.

Case 3. A 9-year-old girl with long-standing juvenile rheumatoid arthritis presented with a fever of 39.4°C, myocarditis, intermittent convulsions, a Coomb's-positive hemolytic anemia, and multiple joint contractures. On physical examination, hepatosplenomegaly and a distended abdomen were noted. Barium examinations and mesenteric arteriography, performed because of abdominal pain, were both normal. The plain film of the abdomen subsequently became consistent with small-bowel obstruction. A Ga-67 citrate image demonstrated diffuse increased activity in the abdomen thought to be consistent with peritonitis (Fig. 4). At operation, small-bowel obstruction was found secondary to adhesions. Other adhesions, as well as peritoneal thickening, were noted. Biopsies demonstrated nonspecific vasculitis. The peritoneal fluid was sterile.

Case 4. An 81-year-old man with a long history of duodenal ulcer presented with severe epigastric pain and a board-like abdomen. (T 36.8°C; P 100; BP 152/70; the WBC was 11,000.) Emergency laparotomy revealed a perforated duodenal ulcer with diffuse peritonitis. A Billroth II procedure was performed. Cultures of the peritoneal fluid revealed *Klebsiella* and enterococci. Ten days postoperatively a Ga-67 citrate scan was performed because of continuing fever and leukocytosis; it was interpreted as consistent with persisting peritonitis (Fig. 5). The patient recovered after a long course of antibiotics.

Case 5. A 52-year-old man was admitted to the coronary care unit with acute chest pain. The patient had a long history of duodenal ulcer, treated medically. Physical examination revealed profuse perspiration but was otherwise unremarkable (T 36.7°C; P 50; BP 110/80; the WBC was 8,500). Electrocardiographic and enzymatic changes documented an acute myocardial infarction. During the patient's convalescence, his hemoglobin dropped from 14 to 11, and a gastric aspirate revealed bright-red blood. His abdomen became distended and the white-cell count rose to 14,000. Blood culture revealed *E. coli* sepsis. A barium meal demonstrated a duodenal ulcer crater. The Ga-67 citrate scan showed a pattern consistent with peritonitis (Fig. 6), with extension from the right subhepatic space down the right paracolic gutter into the pelvis as well as the left infracolic region. The patient was treated with intravenous antibiotics and gradually improved. A repeat radiogallium scan was normal.

DISCUSSION

Uptake of Ga-67 citrate has been well documented in defining localized inflammatory processes. It has apparently been less widely used in diffuse inflammation or bacterial peritonitis, although two case reports have illustrated uptake in tuberculous peritonitis (*1,2*). Four of our cases, demonstrating diffuse Ga-67 abdominal uptake that conformed to the contours of the peritoneal cavity, underwent laparotomy, where diffuse disease was found. Case 4

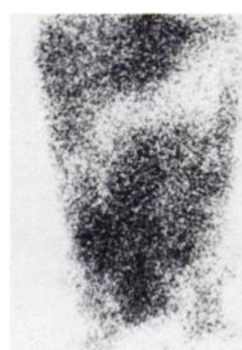

FIG. 4. Diffuse abdominal activity of Ga-67 in Case 3. This was due to vasculitis, and peritoneal fluid was sterile. Oblique line of decreased activity appears below liver.

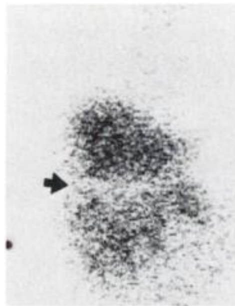

FIG. 5. Anterior rectilinear scan in Case 4, showing Ga-67 distribution within liver and right infracolic space. At prior surgery, perforated duodenal ulcer was found. Horizontal lucent band (arrow) appears between liver and infracolic structures.

FIG. 6. Anterior rectilinear scan of the distribution of Ga-67 in Case 5. Peritonitis had resulted as a complication of a duodenal ulcer.

demonstrated diffuse peritoneal infection secondary to duodenal bulb perforation. Case 1 had infection from a perforated small-bowel segment. Case 2 had adhesions but may also have had bacterial peritonitis in the past. Case 3 also demonstrated only adhesions at operation and nonspecific vasculitis on biopsy. Only Case 5 did not undergo operative confirmation of the clinical impression.

Let us analyze the scan appearances in terms of the anatomy of the region. As with contrast peritoneography, the anatomic divisions of the peritoneum have also been demonstrated by the direct injection of radionuclides such as Au-198 colloid (*7*). The spaces so defined can be delineated in diffuse disease of the peritoneal cavity, offering diagnostic aid. Figure 7 illustrates the major divisions of the peritoneal spaces.

Analysis of two of our images (Figs. 1 and 3) reveals an oblique lucency directed toward the left upper quadrant. This is to be distinguished from the radionuclide image in which the lucency is horizontal (Fig. 5). Relating these findings to anatomical boundaries appears feasible. The peritoneal cavity is divided into compartments by peritoneal reflections and mesenteric attachments. Short of overwhelming peritonitis, the spread of infections tends to respect these anatomic boundaries. Movement of abdominal infections usually occurs by the most accessible routes. These are the paracolic gutters connecting the pelvis to the subphrenic and subhepatic regions on the right and the subphrenic space on the left (*3*). Even these routes of spread are not as common as localized restriction of inflammatory processes by adhesions. In overwhelming peritonitis, however, the inflammation does not respect the usual anatomic boundaries, and a diffuse process occurs. The major barrier of the abdominal cavity is the transverse mesocolon (*3*). Below this, the root of the small bowel mesentery divides the inframesocolic region into right and left infracolic spaces (Fig. 7). The axis of the transverse mesocolon is horizontal, whereas the axis of the root of the mesentery is oblique, upwards and to the left. The root of the mesentery inserts at the ileal–cecal valve region and extends upwards to the duodenal–jejunal junction. The right infracolic space is relatively small, bounded by the root of the mesentery and the peritoneal reflection of the ascending colon. The left infracolic space is larger, being confined by the root of the mesentery and the left colic reflection, but open to the pelvis.

It is reasonable to assume that inflammatory processes occurring to the left of the root of the mesentery in the left intracolic space migrate downward, although in overwhelming infections the root of the mesentery may be breached. Hence, an oblique lucency, representing the root of the mesentery, would show on the positive Ga-67 citrate scan or form the upper margin of the image. This occurs in disease processes originating in the jejunum and ileum, both of which are suspended from the mesenteric root. Processes originating from the duodenal bulb, which is a supracolic peritoneal structure, would not have the root of the mesentery as a superior boundary, but may be limited by the transverse mesocolon. Thus, a horizontal lucency interrupting the Ga-67 image may be expected on the scan. The superior margin would not be the oblique mesenteric root but, instead, the diaphragm or posterior ligament of the liver (Fig. 7). These conjectures appear to be correct in our patients. Case 1 had an ileal perforation and the upper margin of the peritoneal uptake was oblique, conforming to the root of the mesentery (Fig. 1). Likewise, Case 2 (Fig. 3) had ileal surgery on the left side of the abdomen, and her inflammatory process was also delineated by an oblique line at the upper margins.

On the other hand, Case 4 had a surgically proven duodenal ulcer and the upper margin of the positive radiogallium image was transverse (Fig. 5), sug-

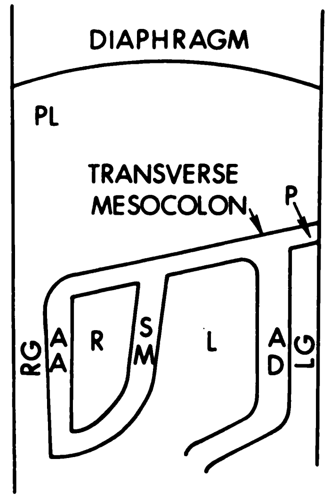

FIG. 7. Schematic diagram of the major divisions of the peritoneum. P = Phrenicocolic ligament, R = Right infracolic space, L = Left infracolic space, RG = Right paracolic gutter, AA = Attachment of the ascending colon, SM = Mesentery of the small bowel, AD = Attachment of the descending colon, LG = Left paracolic gutter, PL = Posterior ligaments of liver. (Redrawn from M. A. Meyers, *Am J Roentgenol* 119: 198, 1973, by permission.)

gesting supramesocolic disease. A transverse line interrupting the image is assumed to be the root of the mesentery. In Case 5 we had an opportunity to apply these anatomic criteria. Although the clinical evidence strongly suggested perforated duodenal ulcer with peritonitis, small-bowel necrosis was also a consideration. Operative intervention was contraindicated due to acute myocardial infarction, but would have been mandatory if small-bowel infarction with peritonitis was the primary diagnosis. The impression of perforated ulcer, however, was reinforced by a radiogallium image delineating a pattern consistent with peritonitis secondary to supramesocolic disease, rather than a left-infracolic collection limited by the root of the mesentery. The patient survived with a prolonged course of intravenous antibiotic therapy and responded well to an anti-ulcer regimen.

Appreciation of the anatomical outline of the Ga-67 image of the peritoneum can also be expected to aid in the differentiation between diffuse peritoneal and diffuse retroperitoneal disease, for the latter would not outline the transverse mesocolon or the root of the mesentery. Furthermore, the retroperitoneum can be divided into three anatomic compartments, each with its own definable contours structured by fascial planes (*4*). Myerson and coworkers (*5*) have demonstrated two cases of diffuse pancreatic disease conforming to the outlines of the anterior pararenal space of the retroperitoneum.

Lateral images may be of limited use in anatomical analysis, since the root of the mesentery reaches the same height as the mesocolon. Furthermore, activity in the paracolic gutters would dominate the lateral images. The lateral view would also be expected to be of limited use in distinguishing peritoneal from retroperitoneal processes, since the latter expand anteriorly. An example of this is provided by Kennedy and coworkers (*6*), who published a lateral view of a pseudocyst of the pancreas confined to the anterior pararenal space. On lateral scan the mass is seen to be anterior in position. Furthermore, the retroperitoneal space (especially the anterior pararenal space) extends as far, both superiorly and inferiorly, as does the peritoneal cavity.

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REFERENCES

1. STEINBACH JJ: Abnormal ^{67}Ga-citrate scan of the abdomen in tuberculous peritonitis: Case Report. *J Nucl Med* 17: 272–273, 1976

2. BARAN RJ, FRATKIN MJ: Gallium-67 scanning of tuberculous peritonitis. *J Nucl Med* 17: 1020–1021, 1976

3. MEYERS MA: The spread and localization of acute intraperitoneal effusions. *Radiology* 95: 547–554, 1970

4. MEYERS MA, WHALEN JP, PEELE K, et al.: Radiologic features of extraperitoneal effusions. *Radiology* 104: 249–257, 1972

5. MYERSON PJ, BERG GR, SPENCER RP, et al: Ga-67 spread to anterior pararenal space in pancreatitis. *J Nuci Med*: in press

6. KENNEDY TD, MARTIN NL, ROBINSON RG, et al: Identification of an infected pseudocyst of the pancreas with ^{67}Ga-citrate: Case Report. *J Nucl Med* 16: 1132–1134, 1975

7. BRIGGS RC: Combined liver-lung scanning in detecting subdiaphragmatic abscess. *Semin Nucl Med* 2: 150–156, 1972