Diagn Interv Radiol 2008; 14:212–220

ORIGINAL ARTICLE

Complications of continuous ambulatory peritoneal dialysis: evaluation with CT

Banu Çakır, İsmail Kırbaş, Belma Çevik, Esra Meltem Kayahan Ulu, Ahmet Bayrak, Mehmet Coşkun

PURPOSE
To assess the frequency of abdominal computed tomography (CT) findings of continuous ambulatory peritoneal dialysis (CAPD)-related complications.

MATERIALS AND METHODS
CT examinations of 42 patients (23 females and 19 males; median age, 46.5 years; age range, 22–70 years) with end-stage renal disease receiving CAPD were investigated retrospectively. CT examinations were performed with a suspicion of CAPD-related complications who were admitted to dialysis unit with various complaints. Images were obtained from the level of the dome of the diaphragm to the pelvis with an 8-mm slice thickness before and after intravenous contrast injection. Oral contrast material was performed in 17 of these patients. CT peritoneography was performed in one patient.

RESULTS
Complications of CAPD detected on CT studies included peritoneal thickening (n = 19; 45.7%), peritoneal calcifications (n = 2; 4.7%), peritoneal enhancement (n = 2; 4.7%); intraperitoneal loculation of fluids (n = 16; 38.1%), dilatation of bowels secondary to adhesions (n = 3; 7.1%); leakage of dialysis fluid adjacent to the entry site of the CAPD catheter (n = 6; 14.3%)(leaked dialysis fluid was loculated near the catheter in 4 of these patients); abscesses (n = 3; 7.1%); hernias (n = 5; 11.9%); hematomas (n = 5; 11.9%); tuberculous lymphadenitis (n = 2; 4.7%); bowel perforation (n = 2; 4.7%); ischemic bowel disease (n = 1; 2.4%); acute pancreatitis (n = 2; 4.7%); and catheter malposition (n = 1; 2.4%).

CONCLUSION
CT of abdomen is useful in detection of CAPD-related complications. Peritoneal thickening and intraperitoneal loculation of fluids due to peritonitis were the most common complications of CAPD detected on abdominal CT.

Key words: • *peritoneal dialysis, continuous ambulatory* • *complications* • *computed tomography*

From the Department of Radiology (B.Ç. ✉ *banutopcu@yahoo.com*), Başkent University School of Medicine, Ankara, Turkey.

Received 18 March 2008; revision requested 24 May 2008; revision received 28 May 2008; accepted 15 September 2008.

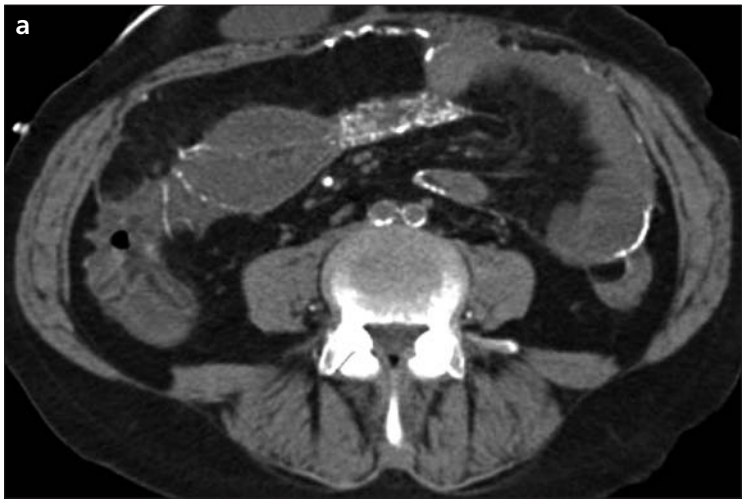
Continuous ambulatory peritoneal dialysis (CAPD) is an established treatment option for patients with end-stage renal disease (ESRD). This form of renal replacement therapy is used in most children with end-stage renal disease who are awaiting renal transplantation. CAPD is also preferred over hemodialysis for patients whose vascular access is difficult or for those who have diabetes mellitus or cardiovascular problems. In addition, many patients choose CAPD because it allows more independence and mobility (1). However, certain complications are more frequent with CAPD than with hemodialysis and often force cessation of the CAPD. Infections at the tunnel, exit sites, and peritonitis followed by localized fluid collections, peritoneal adhesions, hernias, and leaks are the most common complications (2, 3). Diagnostic imaging of the complications of CAPD is important because such evaluation can aid in the treatment decision process. Since use of CAPD for renal replacement therapy has been increasing, computed tomography (CT) has been a useful diagnostic tool for the assessment of CAPD-related complications. The purpose of this study was to establish the frequency of CT findings of CAPD complications.

Materials and methods

From January 1996 to February 2007, 42 patients (23 females and 19 males; median age, 46.5 years; age range, 22–70 years) who were treated with CAPD for end-stage renal disease and were referred for abdominal CT examinations with a suspicion of CAPD-related complications were evaluated retrospectively. The patients were admitted to the dialysis unit with various complaints including abdominal pain, fever, nausea, vomiting, and cloudy dialysate. All patients started on CAPD between 1996 and 2004. Ten eventually died of sepsis or cardiopulmonary complications during CAPD therapy. Abdominal CT examinations were performed on a 4-channel multi-row detector CT scanner (Somatom Plus Four Volume Zoom; Siemens Medical Systems, Erlangen, Germany) and on a 16-channel multi-row detector CT scanner (Sensation 16; Siemens Medical Systems, Erlangen, Germany) following an intravenous injection of 150 mL of contrast material at a rate of 4 mL/s using a power injector. Images were obtained from the level of the dome of the diaphragm to the pelvis with 8-mm slice thickness before and after contrast material injection at portal (at 60th second) and late phase (at 5th minute). Enhancement of peritoneal structures was evaluated in late phase images. In addition, oral contrast material was given to 17 of these patients. CT peritoneography was performed in only one patient.

Results

Peritonitis was the most frequent complication. In 19 patients (45.2%), peritoneal thickening was observed. Peritoneal calcifications



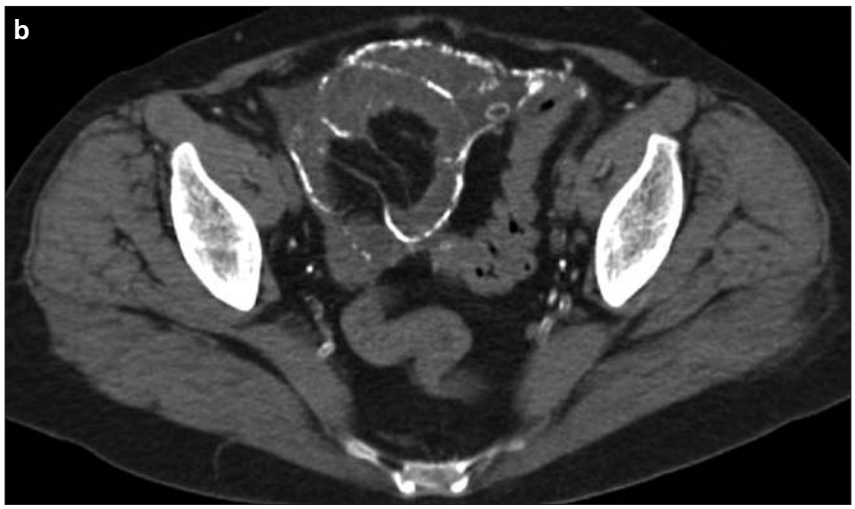


Figure 1. a, b. Precontrast CT images **(a, b)** of a 51-year-old woman receiving continuous ambulatory peritoneal dialysis for 11 years show linear calcifications involving the peritoneum and small bowel.

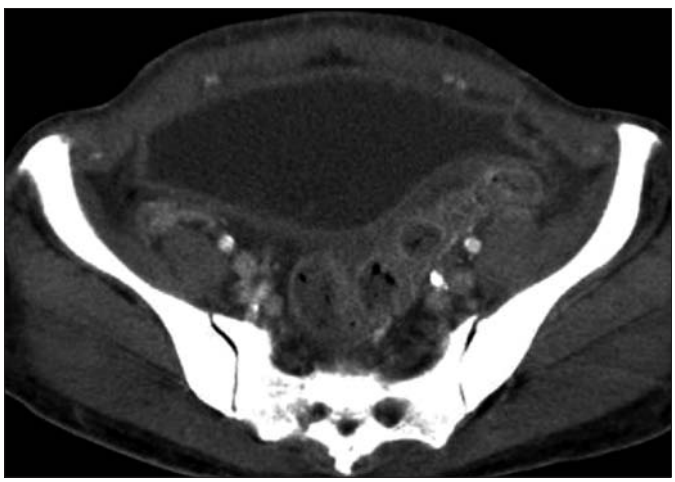


Figure 2. Postcontrast CT image of a 44-year-old woman receiving continuous ambulatory peritoneal dialysis for 7 years shows peritoneal thickening and enhancement.

were observed in 2 of these patients (4.7%) (Fig. 1), and contrast enhancement of peritoneum was detected in 2 of them (4.7%) (Fig. 2). CT scans revealed numerous calcifications involving peritoneum, small bowel wall, and cecum wall in one patient and calcifications involving the peritoneum in another. All 19 patients had a history of recurrent peritonitis (2–10 peritonitis episodes per patient; mean number of peritonitis episodes, 5). They were admitted to the dialysis unit with a history of fever, abdominal pain, and cloudy dialysate. The most common cause of peritonitis was bacterial, and staphylococci were the most common organisms isolated from peritoneal fluid (n = 24; 57.1%). Other causative microorganisms were species of *Escherichia* (n = 10; 23.8%), *Streptococcus* (n = 4; 9.5%), *Pseudomonas* (n = 2; 4.7%), *Corynebacterium* (n = 2; 4.7%), Diphtheroids (n = 2; 4.7%), *Klebsiella* (n = 1; 2.4%), *Acinetobacter* (n = 1; 2.4%), *Enterobacter* (n = 1; 2.4%), and *Enterococcus* (n = 1; 2.4%). *Brucella* peritonitis was observed in one patient. Although no microorganisms were isolated in the peritoneal fluid in some patients with peritonitis, antibiotic treatment was started empirically.

Abscesses were detected in 3 patients (7.1%) on CT examinations; 2 (4.7%) were retroperitoneal, 1 was pelvic. Percutaneous drainage catheters were inserted into the abscesses under ultrasound guidance. Retroperitoneal abscesses were in the left psoas muscle in one patient and in front of the right psoas muscle in another patient (Fig. 3). No microorganism was isolated from culture of the left psoas muscle abscess; *Pseudomonas aeruginosa* grew in culture of the second patient. Gram staining of the aspirated pelvic abscess revealed gram-negative bacilli (Fig. 4).

Intraperitoneal fluid loculation as a result of adhesions were detected in 16 patients (38.1%) (Fig. 5). In one of these patients (2.4%) fluid collection was present between anterior abdominal wall muscles and in the other (2.4%) within subcutaneous soft tissues. In the remaining 14 patients, intraperitoneal fluid collections were observed. Hemorrhage was seen in one patient with loculated fluid adjacent to the liver. In 3 patients (7.1%) dilatation of bowel caused by adhesions were observed (Fig. 6).

Leakage of dialysis fluid adjacent to the entry site of the CAPD catheter was seen in 6 patients (14.3%). Loculated fluid collections were observed near the CAPD catheter in 4 patients (9.5%). Ultrasound-guided aspiration of loculated fluid revealed coagulase-negative

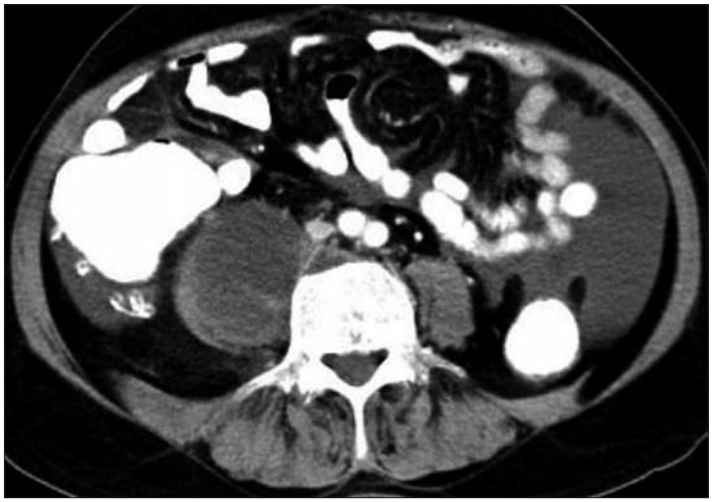


Figure 3. Postcontrast CT image shows retroperitoneal abscess within the right psoas muscle of a 61-year-old man receiving continuous ambulatory peritoneal dialysis for 2 years. *Pseudomonas aeruginosa* was isolated from the culture specimen of the collection.

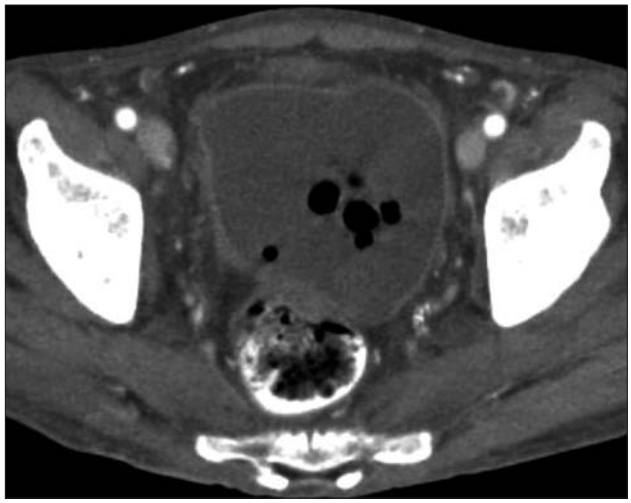


Figure 4. Postcontrast CT image demonstrates pelvic abscess containing pockets of air and enhancement of the wall. Gram-negative bacilli were detected after percutaneous US-guided drainage.

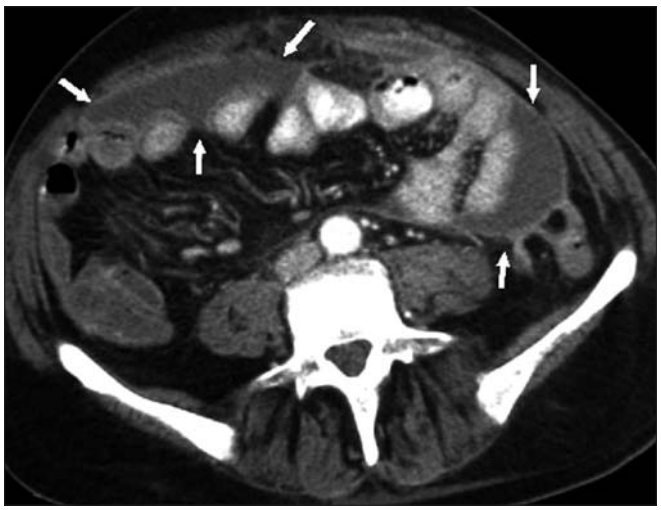


Figure 5. Postcontrast CT image reveals loculated fluid collections *(arrows)* with peritoneal thickening in a 44-year-old-man with continuous ambulatory peritoneal dialysis.

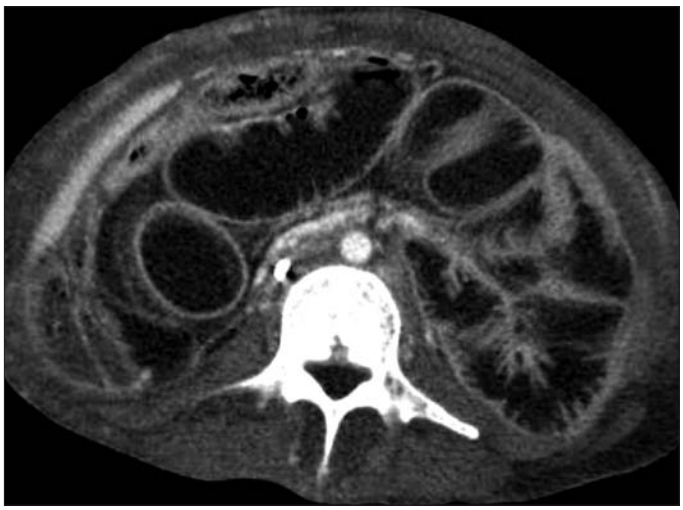


Figure 6. Postcontrast CT image of a 40-year-old man receiving continuous ambulatory peritoneal dialysis for 4 years shows dilatation of small bowel due to adhesions and loculated fluid collection in the right upper quadrant.

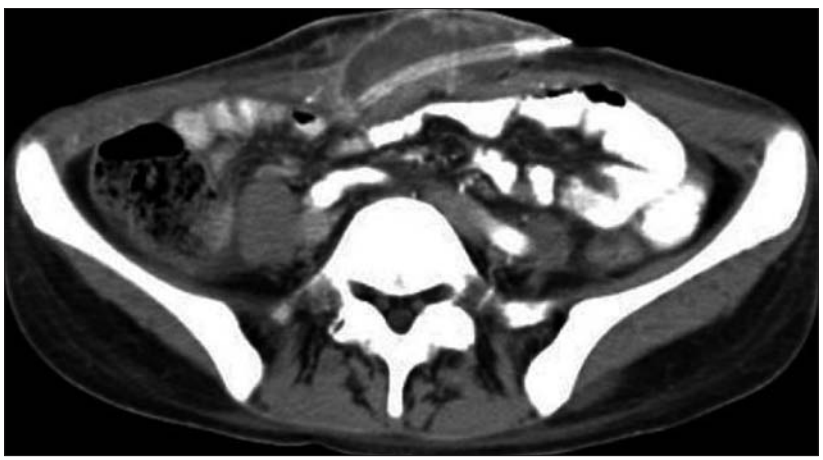


Figure 7. Postcontrast CT image shows a loculated fluid collection adjacent to the catheter in a 22-year-old woman receiving continuous ambulatory peritoneal dialysis for 3 years. *Staphylococcus aureus* was isolated from the culture of fluid.

staphylococcus in one patient (Fig. 7) and *Candida* in another. No microorganisms were detected in the remaining 4 patients (Fig. 8).

Five patients had hernias (11.9%)—4 incisional and 1 inguinal. Small bowel and fluid were observed in 2 incisional hernias (4.7%), and small bowel dilatation was observed proximal to the hernia as a consequence of bowel obstruction in the hernia sac (Fig. 9). Fluids were detected in the incisional hernia sac in 2 patients (4.7%) and inguinal hernia sac in 1 patient.

Hematomas were observed in 5 patients (11.9%). After CAPD catheters were removed, intraperitoneal hematoma, large bowel hematoma, and

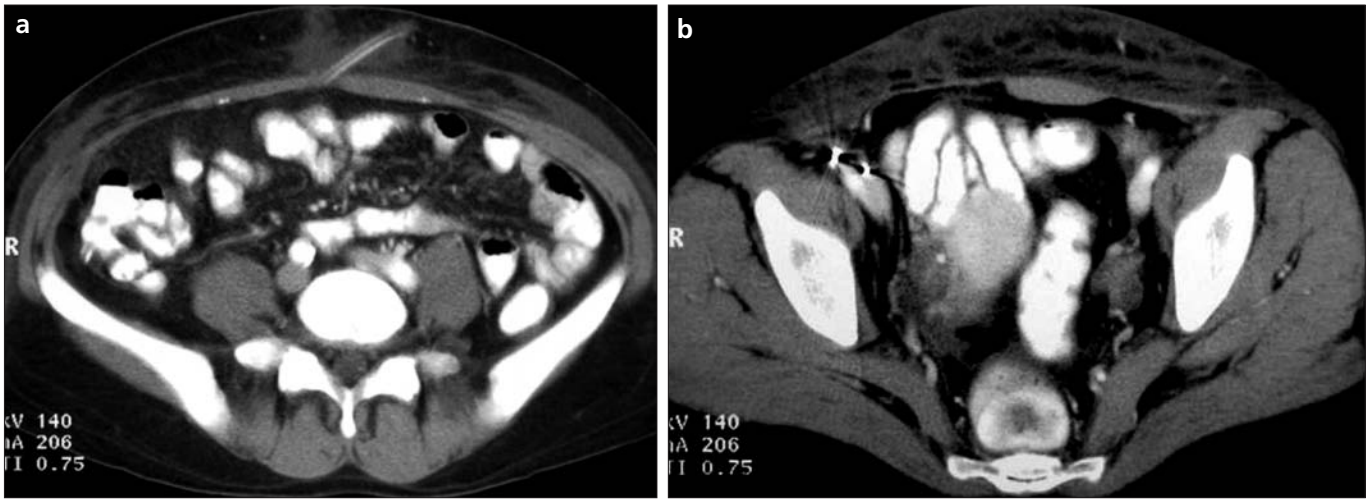


Figure 8. a, b. Postcontrast CT images illustrate fluid near the catheter **(a)** and subcutaneous soft tissue of abdominal wall **(b)** secondary to leaks of dialysate.

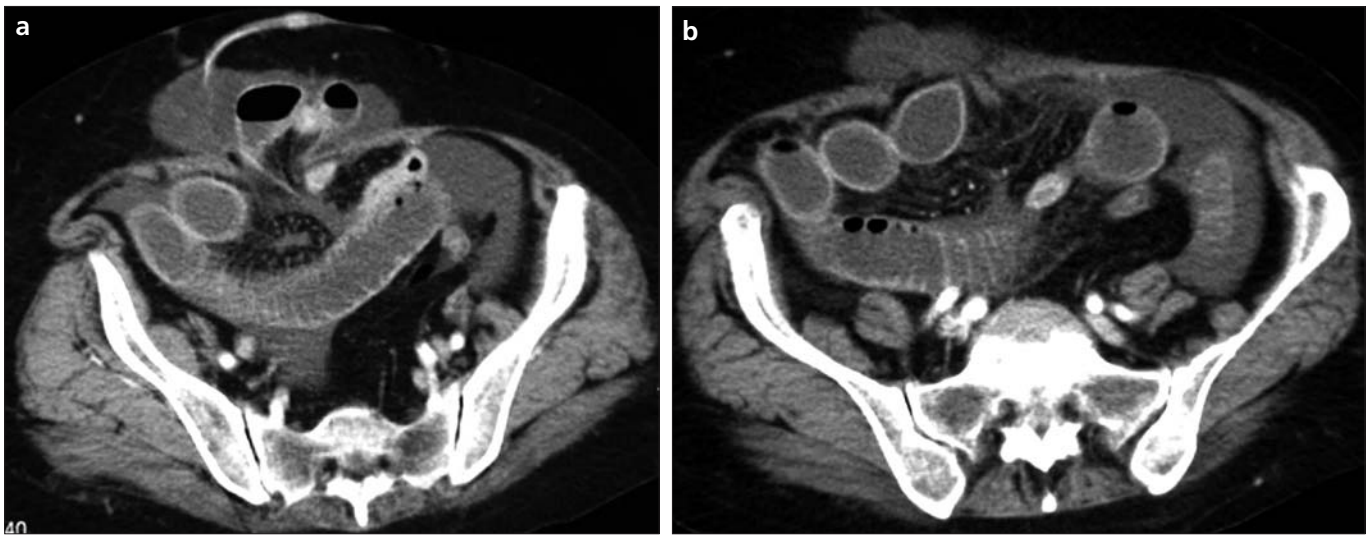


Figure 9. a, b. Postcontrast CT image **(a)** shows hernia containing small bowel and peritoneal fluid at the site of catheter insertion. A more cranial section **(b)** shows dilatation of the small bowel proximal to the hernia sac due to obstruction.

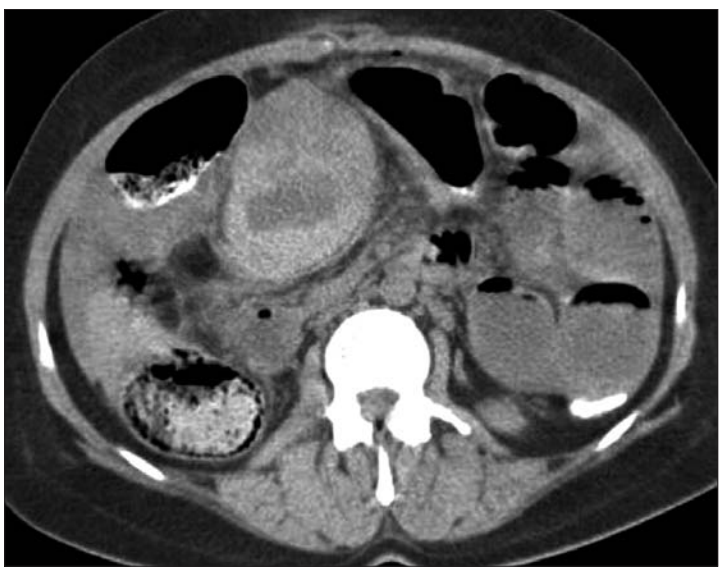


Figure 10. Precontrast CT image reveals hematoma in the gastrocolic ligament following adhesiolysis surgery in a 47-year-old-woman.

subcutaneous hematoma were each found in individual patients. Hematoma in gastrocolic ligament was detected following adhesiolysis surgery (Fig. 10). Duodenal intraluminal hematoma in one patient was observed (Fig. 11). Two of 5 patients (4.7%) died of septic shock; another died of pulmonary arrest. Abdominal tuberculous lymphadenitis was diagnosed by histopathologic evaluation in 2 patients (4.7%) (Fig. 12).

Findings of bowel perforation in 2 patients (4.7%) were revealed on CT examination. At surgery, perforation of the ileum was found in one patient (Fig. 13) and sigmoid bowel perforation in another. Ischemic bowel disease was observed in one patient. Abdominal CT showed lack of enhancement and

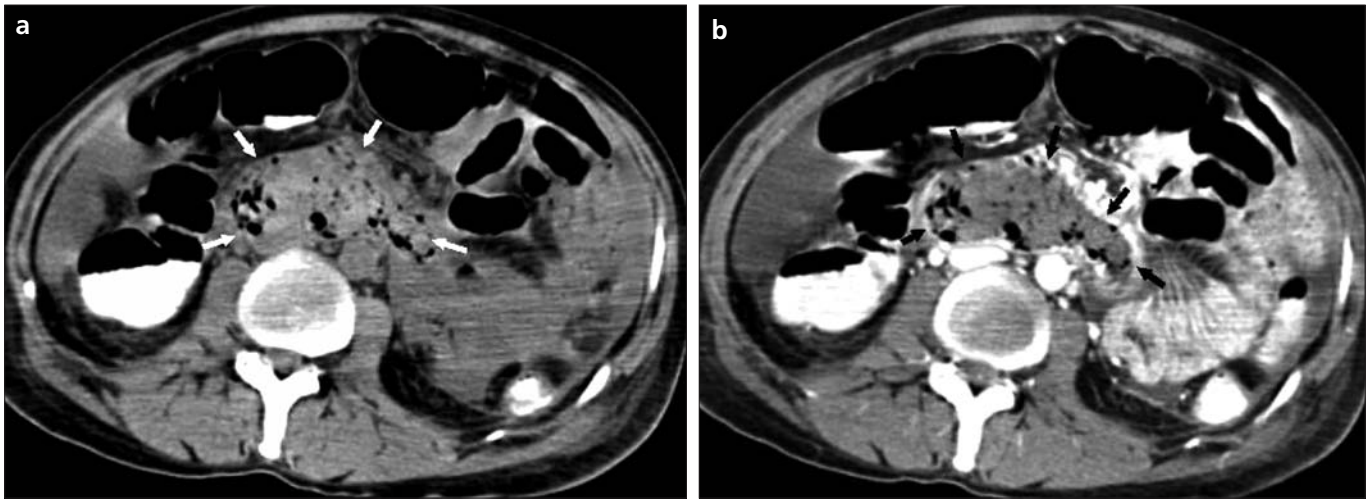


Figure 11. a, b. Pre- **(a)** and postcontrast **(b)** CT images show duodenal intraluminal hematoma *(arrows)* in a 43-year-old woman.

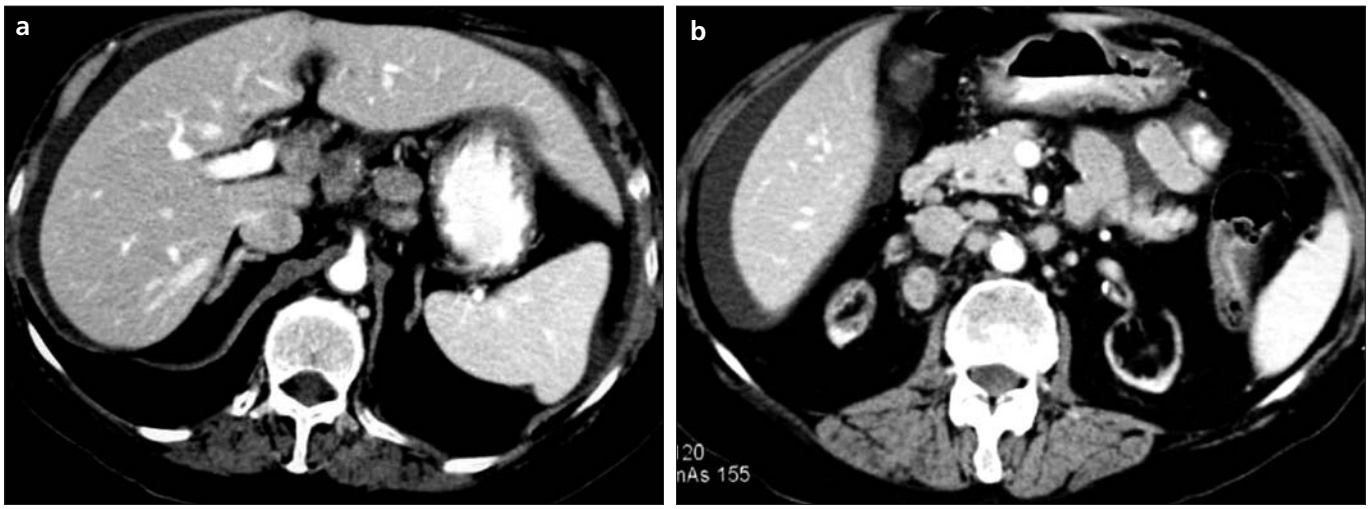


Figure 12. a, b. Postcontrast CT images **(a, b)** of a 67-year-old woman show enlargement of lymph nodes in the portal hilar, paraceliac, paraaortic, and paracaval areas consisting of peripheral enhancement with a low-density center.

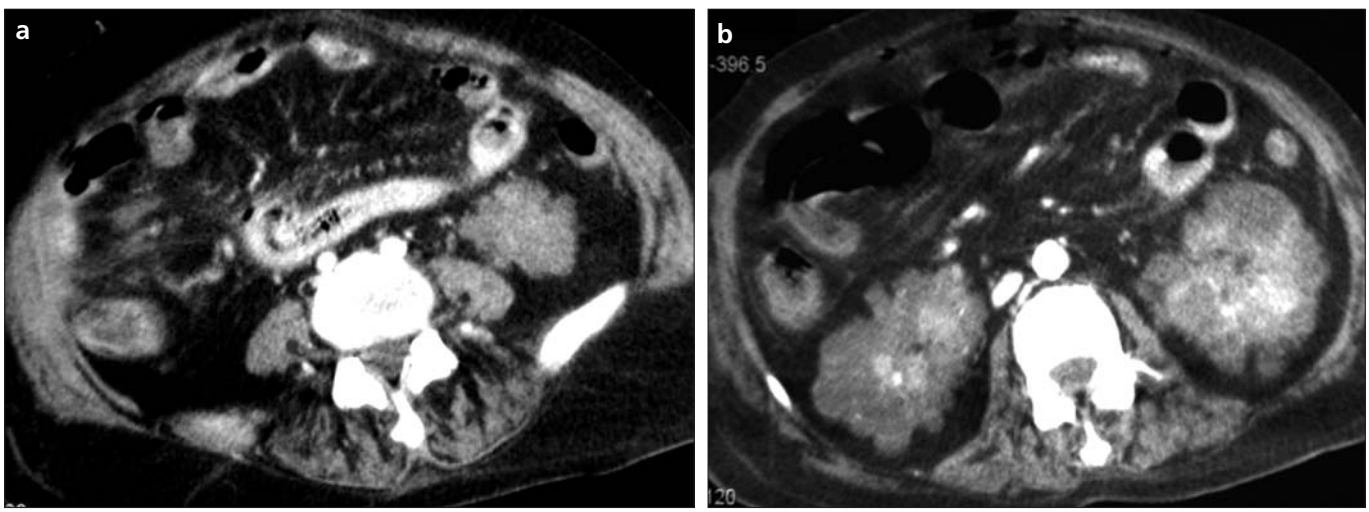


Figure 13. a, b. Postcontrast CT images **(a, b)** demonstrate wall thickening of the ileum, free air, and stranding of the mesentery adjacent to ileum **(a)** and intraperitoneal free air **(b)**. Ileal perforation was confirmed by surgery.

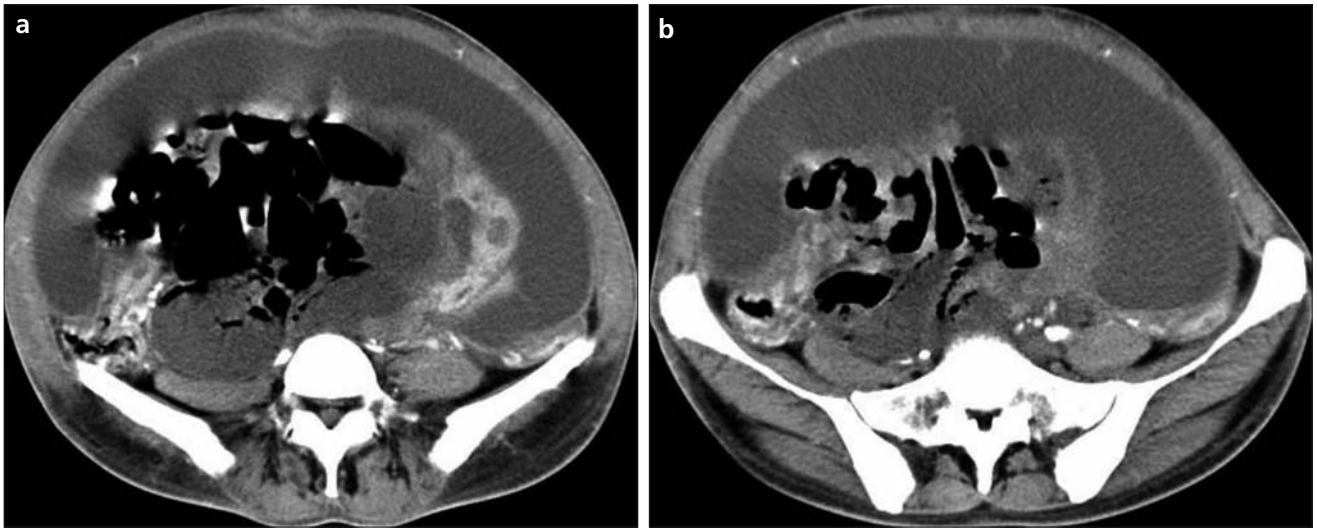


Figure 14. a, b. Postcontrast CT images **(a, b)** of a 44-year-old woman with bowel ischemia show lack of enhancement **(a)** and intramural gas of the small bowel wall **(b)** in the right side of abdomen.

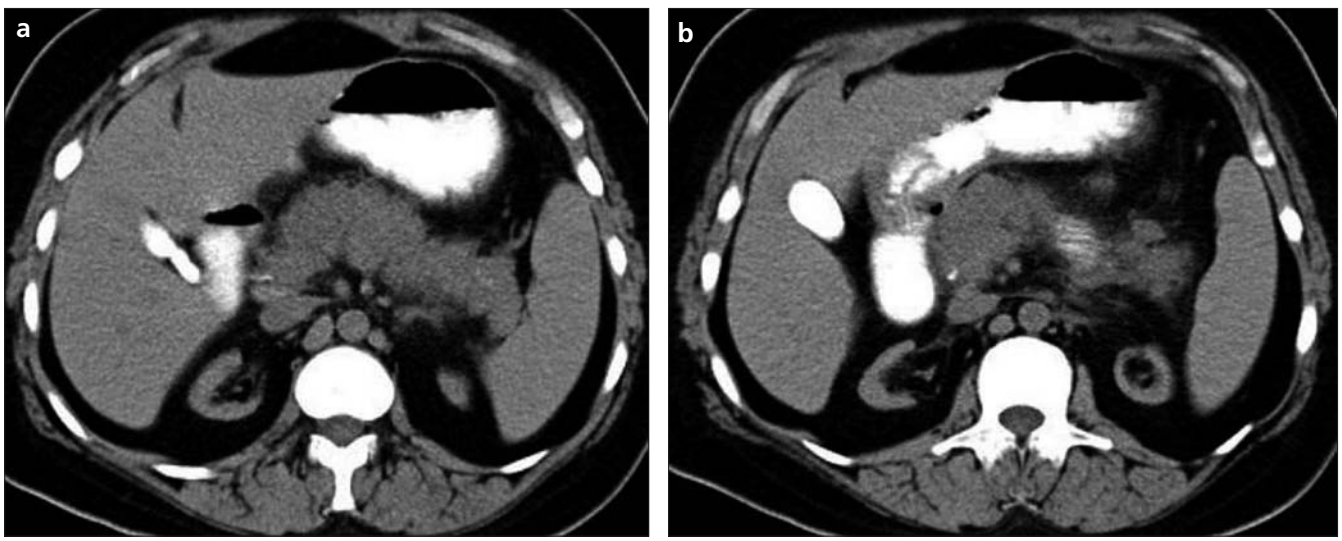


Figure 15. a, b. Precontrast CT images **(a, b)** of a 32-year-old woman with acute pancreatitis show diffuse enlargement of the pancreas **(a)** and peripancreatic inflammation **(b)**.

intramural gas in small bowel wall (Fig. 14). Occlusion of inferior mesenteric artery and distal abdominal aorta and stenosis secondary to extensive atherosclerosis in superior mesenteric artery were detected by digital subtraction angiography (DSA). The patient's condition rapidly deteriorated, and she died after DSA examination.

Acute pancreatitis was detected in 2 patients (4.7%); one of the patients had 5 pancreatitis episodes, and the other had 3. CT scans revealed stranding in peripancreatic soft tissue and diffuse enlargement of the pancreas, and laboratory findings confirmed acute pancreatitis (Fig. 15). In a patient with a history of 5 episodes of pancreatitis, findings of chronic pancreatitis (including atrophy of the pancreas and multiple calcifications) were observed after 4 years by CT imaging.

CT peritoneography was performed in one patient, revealing catheter malposition (Fig. 16). CAPD catheter was placed between parietal peritoneum and anterior abdominal muscles. CAPD catheter was replaced by surgery.

Discussion

CAPD complications are not infrequent; radiologic methods are used in both diagnosis and treatment of these complications.

Peritonitis is one of the most frequent complications of CAPD and usually causes infection or breakdown of the sterile technique at the catheter exit site. In the majority of cases, diagnosis of peritonitis can be performed by examination of the dialysis fluid, and there is little role for radiology in establishing the initial diagnosis. However, radiology may be of value in localization and drainage of loculated fluid collections or abscess, biopsy of inflammatory masses, and exclusion of other causes of intra-abdominal sepsis (4). If recurrent peritonitis persists despite antibiotic therapy, complications including peritoneal thickening, peritoneal enhancement, peritoneal calcifications, loculated fluid collections, abscesses, and adhesions may be identified by CT imaging. In this study, 19 patients (45.2%) had peritoneal thickening following multiple peritonitis episodes on

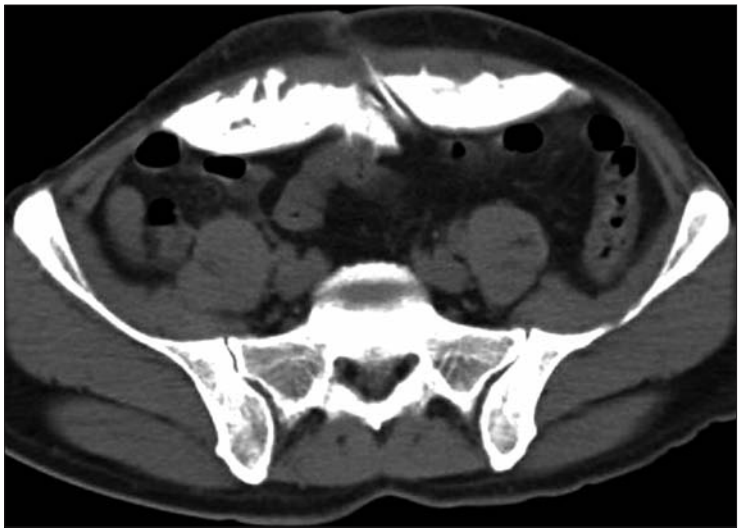


Figure 16. CT peritoneography reveals malposition of the dialysis catheter. Contrast material infused from the catheter disperses between fascia and abdominal muscles in abdominal wall.

CT scans. Two had peritoneal calcification and 2 had peritoneal enhancement. Peritoneal thickening and calcifications in 2 patients were suggestive of sclerosing encapsulating peritonitis. Sclerosing encapsulating peritonitis is one of the most important complications of CAPD. The diagnosis of the disease is usually made by laparotomy (5). Unfortunately, no histologic proof was available in our patients.

Brucella peritonitis was demonstrated in one patient (2.4%). *Brucella* peritonitis is a very rare complication. In our patient, results of a serum agglutination test and blood cultures were negative; however, the patient's peritoneal fluid agglutination titer was 1:160 and samples inoculated into BACTEC (Becton Dickinson) bottles yielded *Brucella melitensis*. It is possible that the peritoneal catheter provides a conducive site for microbial colonization for *Brucella* species and other gram-negative or fungal organisms (6). In our patient, since the organism could not be isolated from blood samples, transmission seems to be the result of direct inoculation. CT examination revealed peritoneal thickening, loculated fluid collections and small bowel wall thickening.

Retroperitoneal abscesses in 2 patients, pelvic abscess in 1 patient, and intraperitoneal loculation of fluids secondary to adhesions in 16 patients (38.1%) were revealed on CT examinations; all of these patients had a history of recurrent peritonitis. The most frequent cause of dialysate maldistribution and loculation was adhesions resulting from previous bouts of severe and prolonged peritonitis (1). Ultrasound-guided catheters were placed into the abscesses percutaneously and antibiotic treatment was initiated.

Leakage of dialysis fluid adjacent to the entry site of the CAPD catheter was shown in 6 patients (14.3%). Four (9.5%) had loculated fluid collections near the CAPD catheter. Leakage of dialysis fluid from the peritoneal cavity is a relatively frequent occurrence and generally has no clinical significance. However, it may be a problem for some patients, particularly when it causes pain or discomfort during dialysis. Leakage of the fluid into the anterior abdominal wall occurs most frequently from the site of insertion of the dialysis catheter into the peritoneum or through defects in the peritoneum as a result of surgery (4). In addition, loculated fluid may form a nidus for infection. Thus, CT examinations may be useful in patients with suspected foci. In this study, all loculated fluids were drained percutaneously, and treatment was started.

Hernias were observed in 5 patients (11.9%). Patients on CAPD have a high incidence of abdominal hernias caused by chronically increased intraperitoneal pressure (7–9). Hernias most commonly occur at the site of incision for catheter insertion, at the umbilicus, and at the inguinal canal. These sites represent potential areas of structural weakness. Umbilical and ventral hernias can develop as a result of a sudden increase in intraabdominal pressure and can also cause abdominal wall and scrotal edema (1, 9). In this study, 4 hernias occurred at the catheter insertion site, and one was inguinal. Bowel obstruction associated with hernia occurred in 2 patients. In such cases, dilated bowel is seen proximal to the hernia, with normal caliber distal to the site of obstruction on CT scans. Hernias were surgically repaired in all 5 patients.

Hematomas developed in 4 patients; hematoma followed removal of CAPD catheter in 3 patients and adhesiolysis surgery in 1 patient. Hemostatic abnormalities due to end-stage renal disease and postoperative complications were considered in the causes of hematomas. In one patient, intraduodenal luminal hematoma was seen on CT imaging. The etiology of upper and lower gastrointestinal bleeding in dialysis patients is similar to that in the population without end-stage renal disease; but in patients with end-stage renal disease, gastrointestinal bleeding is associated with a much higher incidence, severity, need for transfusion, need for surgical intervention, and mortality. Coagulation/platelet defects and the presence of uremic gastritis/colitis are important contributory factors (10).

Patients with chronic renal failure are prone to opportunistic infections, including tuberculosis. For patients undergoing CAPD, the prevalence of tuberculosis is several times higher than that of general population (11). Although tuberculous peritonitis is seen more commonly in CAPD patients, tuberculous lymphadenitis can also be seen (11). The CT findings of abdominal tuberculous lymphadenopathy include circular or ovoid lesions showing peripheral enhancement with a low-density centre. The peripheral enhancing portion has been proposed to correspond to a perinodal, highly vascular, inflammatory response, or granulation tissue within the nodes, whereas the central nonenhancing portion corresponds to caseation or liquefaction necrosis within the nodes (12, 13). This appearance, especially if found in young people, is suggestive, but not pathognomonic, of tuberculosis. Heterogeneous or homogeneous enhancement on contrast-enhanced CT has also been described (12). The lymph nodes involved may occasionally show calcification (14). Abdominal

lymphadenopathy in the portal hilus, hepatogastric ligament, peripancreatic, paraceliac, paraaortic, and paracaval areas was revealed on CT examinations in 2 of our patients. Peripheral enhancement of the lymph nodes was observed. Thoracic CT examinations were unremarkable. Ultrasound-guided lymph node biopsies were performed on both patients. Histopathologic examination determined granulomatous inflammation with caseation necrosis. Patients were treated with antituberculous therapy. Follow-up CT findings showed prominent decrease in lymph node sizes.

Bowel perforation was detected in 2 patients. Extraluminal leakage of oral contrast media, stranding of the mesentery, and intraperitoneal free air were observed in one patient, who had sigmoid perforation. Wall thickening of the ileum, free air, stranding of the mesentery adjacent to the thickened ileum, and intraperitoneal free air were observed in another patient, who had perforation of the ileum on CT scan. The cause of perforation was unclear; it is likely to be significant that both patients had a history of multiple peritonitis episodes. Bowel erosion results from inflammation caused by preexisting shunt infection (15). Peritonitis may cause perforation (16). Focal ischemia and spontaneous perforation are also causative factors.

Bowel ischemia is common in dialysis patients because of severe mesenteric atherosclerosis and episodes of intradialytic hypotension/hypovolemia (10). Besides, CAPD patients routinely undergo the removal of large amount of fluid. Although blood pressure tends to be more stable on CAPD compared to hemodialysis, patients may have severe hypotension (17). Depending on the severity and extent of disease, intestinal ischemia may be manifested on CT by a spectrum of findings, including dilatation of bowel, mural thickening, a mural stratification pattern, mesenteric edema, mural or mesenteric hemorrhage, ascites, pneumoperitoneum, mesenteric arterial or venous thrombi, and portomesenteric venous gas (18, 19). In one of our patients, lack of enhancement and intramural gas in the small bowel wall was observed on abdominal CT imaging. Occlusion of the inferior mesenteric artery and distal abdominal aorta, and stenosis secondary to extensive atherosclerosis in superior mesenteric artery were detected by DSA. The patient did not undergo a surgery because of her poor clinical status; she died after DSA examination.

Previous reports have shown that dialysis patients, especially patients receiving long-term peritoneal dialysis, have an increased risk for acute pancreatitis (20). The reason for increased association of acute pancreatitis with CAPD is not clear. One mechanism could be diffusion of the dialysate through the peritoneum of the lesser sac to the anterior surface of the pancreas, causing chemical irritation. Another mechanism could be linked to the calcium in the peritoneal dialysate; calcium may diffuse through the peritoneum causing "local hypercalcemia" at the pancreas even in the absence of elevation of systemic calcium levels (20). Two patients, both with recurrent peritonitis, had elevated serum amylase and lipase levels; inflammation of peripancreatic soft tissue and diffuse enlargement of the pancreas were observed on CT, consistent with acute pancreatitis. Findings of chronic pancreatitis were observed in one patient on follow-up CT examination.

In one patient, CT peritoneography identified malposition of the CAPD-catheter. CT peritoneography can define catheter position related to the fluid space (1).

A limitation of this study was the inability to differentiate loculated intraperitoneal collections and abscesses from residual dialysis fluid. But peripheral contrast enhancement of abscesses on CT scan and ultrasound-guided aspiration were helpful in considering the diagnosis. It may also be difficult to demonstrate the site of leakage into the extraperitoneal structures by conventional CT, and CT peritoneography could be helpful, improving diagnosis in these patients. In our study, we evaluated CAPD-related CT findings retrospectively, so we were unable to compare these findings with CT peritoneography.

Although adverse events associated with the use of an iodinated contrast medium is significantly higher in patients with chronic renal disease than in the normal population, the benefits of contrast-enhanced CT are well known in diagnosing diseases and in guidance of interventional and therapeutic procedures. In our study, CT examinations were performed on patients with suspected intraabdominal pathology (infection, abscess, hematoma) requiring immediate treatment. The patients were treated immediately by CAPD after CT examination. As a result, risk factors should not serve as an absolute contraindication for these patients to receive intravenous iodinated contrast for diagnostic CT examinations, particularly in patients with life-threatening clinical conditions in whom contrast-enhanced CT may provide valuable information.

In this study, various CAPD-related complications were described with the use of CT examination. Although radiology plays a relatively limited role in detection of complications of peritoneal dialysis, its use in a wide range of problems has been described. Adequate interpretation of radiologic findings demands knowledge of the normal features and complications encountered in patients undergoing dialysis. Appropriate use of radiology may decrease morbidity and mortality in these patients.

References

1. Cochran ST, Do HM, Ronaghi A, Nissenson AR, Kadell BM. Complications of peritoneal dialysis: evaluation with CT peritoneography. Radiographics 1997; 17:869–878.
2. Nissenson AR, Gentile DE, Soderblom RE, Oliver DF, Brax C. Morbidity and mortality of continuous ambulatory peritoneal dialysis: regional experience and long-term prospects. Am J Kidney Dis 1986; 7:229–234.
3. Twardowski ZJ, Tully RJ, Ersoy FF, Dedhia NM. Computerized tomography with and without intraperitoneal contrast for determination of intraabdominal fluid distribution and diagnosis of complications in peritoneal dialysis patients. ASAIO Trans 1990; 36:95–103.
4. Taylor PM. Image-guided peritoneal access and management of complications in peritoneal dialysis. Semin Dial 2002; 15:250–258.
5. Moustafellos P, Hadjianastassiou V, Roy D, et al. Tamoxifen therapy in encapsulating sclerosing peritonitis in patients after kidney transplantation. Transplant Proc 2006; 38:2913–2914.
6. Troidle L, Gorban-Brennan N, Kliger A, Finkelstein F. Differing outcomes of gram-positive and gram-negative peritonitis. Am J Kidney Dis 1998; 32:623–628.
7. Bargman JM. Complications of peritoneal dialysis related to increased intraabdominal pressure. Kidney Int Suppl 1993; 40:75–80.
8. Engeset J, Youngson GG. Ambulatory peritoneal dialysis and hernial complications. Surg Clin North Am 1984; 64:385–392.

9. Kopecky RT, Funk MM, Kreitzer PR. Localized genital edema in patients undergoing continuous ambulatory peritoneal dialysis. J Urol 1985; 134:880–884.
10. Kang J. The gastrointestinal tract in uremia. Dig Dis Sci 1993; 38:257–268.
11. Lui SL, Tang S, Li FK, et al. Tuberculosis infection in Chinese patients undergoing continuous ambulatory peritoneal dialysis. Am J Kidney Dis 2001; 38:1055–1060.
12. Pombo F, Rodriguez E, Mato J, Perez-Fontan J, Rivera E, Valvuena L. Patterns of contrast enhancement of tuberculous lymph nodes demonstrated by computed tomography. Clin Radiol 1992; 46:13–17.
13. Moon WK, Im JG, Yu IK, et al. Mediastinal tuberculous lymphadenitis: MR imaging appearance with clinicopathologic correlation. AJR Am J Roentgenol 1996; 166:21–25.
14. Suri S, Gupta S, Suri R. Computed tomography in abdominal tuberculosis. Br J Radiol 1999; 72:92–98.
15. Di Rocco C. Complications unique to peritoneal shunts. In: Di Rocco C. The treatment of infantile hydrocephalus. Boca Raton: CRC Press, 1987; 2:129–139.
16. Katsivas T, Sokolov R, Miller M, Hever A, Hu B. Primary herpetic peritonitis causing intestinal perforation: case report and review of the literature. Clin Infect Dis 2004; 39:13–16.
17. Shetty A. Hypotension on continuous ambulatory peritoneal dialysis. Clin Nephrol 1996; 45:390–397.
18. Clark RA. Computed tomography of bowel infarction. J Comput Assist Tomogr 1987; 11:757–762.
19. Perez C, Llauger J, Puig J, Palmer J. Computed tomographic findings in bowel ischemia. Gastrointest Radiol 1989; 14:241–245.
20. Quraishi ER, Goel S, Gupta M, Catanzaro A, Zasuwa G, Divine G. Acute pancreatitis in patients on chronic peritoneal dialysis: an increased risk? Am J Gastroenterol 2005; 100:2288–2293.