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Value of magnetic resonance/computed tomography peritoneography technique in the evaluation of dialysate leakage and hernia following peritoneal dialysis

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Abstract

Magnetic resonance and computed tomography peritoneography are diagnostic imaging procedures that involve the intraperitoneal administration of a mixture of contrast material and dialysate for direct visualization of the peritoneal cavity and assessment of the integrity of peritoneal membrane. In a clinical series of patients with end-stage renal disease treated with continuous ambulatory peritoneal dialysis, who presented with genital or low abdominal edema, advanced peritoneographic imaging studies allowed direct visualization of the dialysate leakage and peritoneal hernias. Both magnetic resonance and computed tomography peritoneographic procedures allowed accurate diagnosis of continuous ambulatory peritoneal dialysis–related complications that may need to be addressed promptly so that the effectiveness of continuous ambulatory peritoneal dialysis is not compromised.

Keywords

Renal failure, peritoneal dialysis, hernia, dialysate

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Introduction

Renal disease, characterized as chronic kidney disease and end-stage renal disease, constitutes a significant public health problem that is associated with substantial morbidity and mortality rates, and increased healthcare expenditures.[1] Among patients with end-stage renal disease, approximately 7% use peritoneal dialysis as their renal replacement therapy in the United States.[1–3] As the life expectancy of patients with treated irreversible kidney failure has increased with improved medical care, so too have the total number of patients on dialysis. Despite the improvements in continuous ambulatory peritoneal dialysis (CAPD) that may diminish morbidity, patients with renal failure undergoing CAPD are at risk of developing various infectious and non-infectious complications.[4,5] The development of complications curtails long-term effectiveness of CAPD and eventually leads to cessation of this renal replacement technique. The spectrum of non-infectious complications following CAPD is broad and includes hernias, dialysate leakage, adhesions, loculated fluid collections, catheter dysfunction, sclerosing encapsulating peritonitis, and hepatic steatosis.[2,4–6] Because clinical findings of infectious and non-infectious complications of CAPD are not distinctive, patients often are referred for imaging investigation of the peritoneal cavity.

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Table 1. Patient data.

Patient no.	Gender, age (years)	Indication for CAPD	Time interval CAPD-PG
1	Female, 24	Drug toxicity	2 years, 5 days
2	Male, 68	Diabetes mellitus	1 year, 90 days
3	Male, 67	Diabetes mellitus	1 year, 257 days
4	Male, 72	Hypertension	25 days
5	Male, 68	Diabetes mellitus	274 days
6	Male, 64	Hypertension	218 days
7	Male, 72	Hypertension	124 days
8	Female, 47	Glomerulonephritis	1 year, 322 days
9	Male, 68	Cystic kidney disease	1 year, 9 days
10	Male, 65	Cystic kidney disease	1 year, 280 days
11	Male, 43	Glomerulonephritis	1 year, 145 days

CAPD: continuous ambulatory peritoneal dialysis; PG: peritoneography.

Computed tomography (CT) complemented with peritoneography, that is, CT peritoneography, is recognized as the reference standard imaging technique for examining the peritoneal cavity.[5,7] Magnetic resonance (MR) imaging and MR peritoneography have been helpful in evaluating CAPD-related complications.[5,8] Although previous publications have already emphasized the value of CT or MR peritoneography in the detection of abnormalities within the peritoneal cavity,[7,9–12] a few clinical series limited in the radiology literature have specifically reviewed the MR peritoneographic imaging findings of dialysate leakage complication in CAPD patients.[2,13] The aim of this study was to determine a set of CT/MR imaging peritoneographic findings in CAPD patients presenting with the clinical question of cessation of CAPD due to suspected dialysate leakage or hernia.

Materials and methods

Patient population

MR or CT peritoneography was performed during 18-month period in 11 consecutive patients with end-stage renal disease undergoing CAPD, who presented with clinical suspicion of non-infectious peritoneal complications in the form of soft tissue swelling (genitalia, n=8 patients; lower abdominal wall, n=3 patients) due to presumed dialysate leakage. There were nine men and two women, aged 24–72 years (mean age: 60 years) (see Table 1). In these patients with renal failure, underlying causes were as follows: diabetes mellitus (n=3 patients), hypertension (n=3), glomerulonephritis (n=2), cystic kidney disease (n=2), and drug toxicity (n=1). Time interval between onset of CAPD and dialysate leakage ranged from 25 days (n=1 patient) to almost 2 years (n=10 patients).

Imaging technique

MR imaging

All MR images were acquired with a 1.5-T superconducting MR scanner (Avanto; Siemens, Erlangen, Germany). A standard receive-only body coil centered below the xiphoid process was used for imaging the entire abdomen and pelvis from the dome of the diaphragm to below the external genitalia. Patients were imaged in the supine position. The imaging protocol consisted of coronal and axial T1- and T2-weighted MR images with fat suppression. Images in the sagittal plane were acquired as appropriate. The imaging protocol lasted less than 30 min per patient (Figures 1 and 2).

MR peritoneography

MR peritoneography procedure was performed using a standard method.[2,6,14] The previously infused intraperitoneal dialysate was drained and a solution of diluted gadolinium-containing contrast material (gadopentetate dimeglumine or gadodiamide), the latter being made by mixing 20 mL of the contrast material with 2 L dialysate, was prepared. The infusion was performed with the sterile technique by the trained staff in the hemodialysis unit. After infusion, patients were asked to walk around for about 45–60 min to ensure that the gadolinium-containing contrast material–dialysate mixture is distributed homogeneously throughout the peritoneal cavity. The special precaution was taken for imaging with MR peritoneography while the peritoneal cavity was filled and immediately after the contrast material–dialysate preparation was drained. There was no use of intravenous contrast material that would be contraindicated in patients with end-stage renal disease.

CT peritoneography

As with gadolinium-containing contrast material used for MR peritoneography, iodinated contrast material was injected in a dialysate preparation and infused into the peritoneal cavity via the indwelling catheter during the CT examination. After drainage of the previously infused dialysate, there was an intraperitoneal infusion of a mixture of 100 mL of a non-ionic contrast material

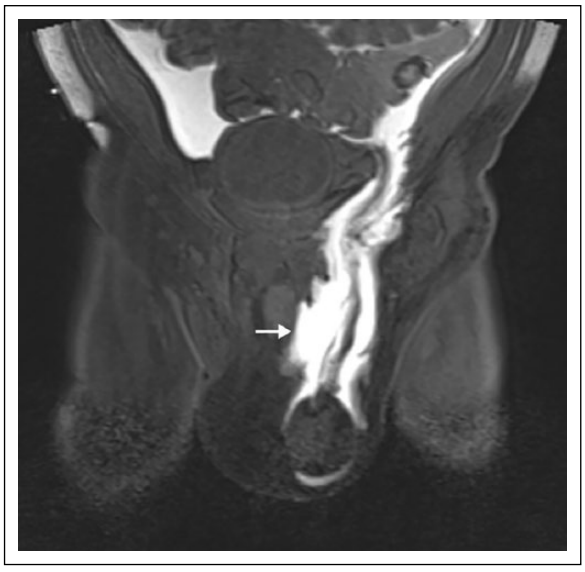

Figure 1. Patient no. 5: coronal fat-suppressed T2-weighted MR peritoneographic image demonstrates excessive dialysate leakage via a patent processus vaginalis on the left (arrow) into the scrotal sac.

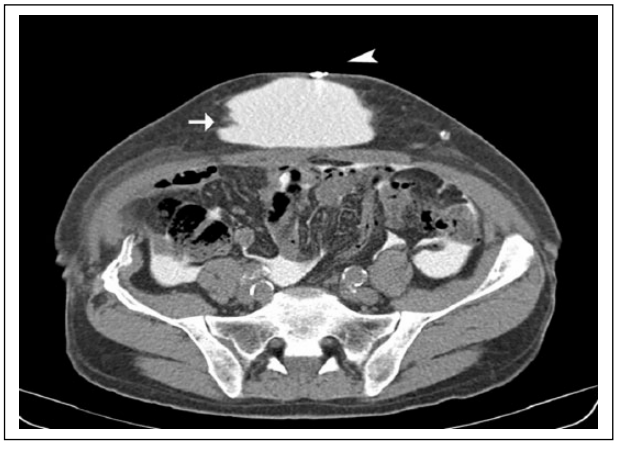

Figure 2. Patient no. 11: axial CT peritoneographic image shows a leak (arrow) in the area of a ventral hernia at the insertion site (arrowhead) of the dialysis catheter.

containing 300 mg of iodine per mL (iopromide and iodixanol) with 2 L dialysate. Sterile technique was used and patients were asked to mobilize and walk to ensure homogeneous distribution of the solution in the peritoneal cavity. Patients lied in the supine position and contiguous axial sections were acquired in a standard fashion. To better demonstrate leaks through the anterior abdominal wall, occasionally, the patients were scanned in the prone position. The contrast material–dialysate mixture was drained at the end of the procedure. Because of the known risk for nephrotoxicity, there was no intravenous administration of contrast material in these patients with residual renal function.

Image analysis

Peritoneographic imaging studies were well tolerated by our patients. The imaging findings were analyzed by the consensus of two board-certified radiologists with particular attention to any complication of CAPD including hernia and its types, dialysate leakage, adhesions, loculated fluid collection, sclerosing peritonitis, and hepatic steatosis—according to established diagnostic criteria. For this study, infectious complications alone (i.e. without other morphologic intraperitoneal abnormalities) were not evaluated. Each known complication of CAPD was tallied separately for this study, even if more than one complication existed in the same patient, because multiple complications may occur independently, cause symptoms, and eventually need different management. The consensus observations with regard to the specified clinical and imaging findings were reviewed systematically during a single reading session. Because of the limited number of patients that met our inclusion criteria, no formal statistical analysis was performed.

Results

Of the 11 patients with soft tissue edema, eight presented with leakage in the external genitalia, and three had a leakage in the anterior abdominal wall and thus allowed the clinical diagnosis of hernia to be suggested in all patients. Advanced cross-sectional peritoneographic studies (MR peritoneography = 8 and CT peritoneography = 3) were considered technically adequate in all patients. The diagnosis of peritoneal hernia was made in six patients, two of whom had bilateral hernias. In the inguinal canal, MR peritoneography showed that hernias were solitary in four of the eight patients with swelling of the genitalia; two patients had an additional contralateral hernia that was not detected on clinical examination. In two additional patients with genital edema, MR peritoneography was diagnostic of subtle leak and not hernia. An abdominal wall leak was diagnosed in three patients (exit site of the catheter = 2 and umbilical hernia = 1).

All our patients with hernias required surgery (hernioplasty) and were reintegrated into CAPD about 3 weeks after successful surgical repair. In these two patients with subtle leakage of dialysate from an undetermined site temporal cessation of CAPD for 4 weeks resulted in reintegration into the peritoneal dialysis group. We recorded no side effects (i.e. nephrogenic systemic sclerosis) associated with the use of gadolinium-based contrast agents following the MR peritoneography procedure.

Discussion

CAPD is a widely accepted renal replacement treatment for end-stage renal disease. In CAPD, the dialysate is infused into the peritoneal cavity via an indwelling catheter, and the

peritoneal membrane, a natural semi-permeable membrane, serves as the dialyser. The technique was first described almost 60 years ago[14] and has been used as an alternative option to hemodialysis.

However, each of these techniques has pros and cons. Advantages of CAPD are summarized in diminished costs, greater independence and mobility for patients who can perform dialysis at home, blood pressure control, minimal cardiovascular stress, improved preservation of residual renal function, and fewer dietary restrictions. Disadvantages of CAPD include hypoproteinemia due to loss of protein through the dialysate, weight gain due to absorption of glucose from the dialysate, hyperlipidemia, and accelerated atherosclerosis. Other, serious disadvantages of CAPD include multiple infectious and non-infectious complications.[7] The infusion of dialysate causes an increase in intra-abdominal pressure, which may, in turn, result in peritoneal herniation or leakage of dialysate.[7] We observed this serious complication in all our patients in whom the effectiveness of CAPD was compromised. In most of our patients, surgery was pursued to restore the integrity of the peritoneal membrane and enable the continuation of dialysis. In those patients where leakage was minimal and could not be identified on the imaging studies, temporal interruption of CAPD and switching to hemodialysis allowed the leak to heal in accordance with previous reports.[15]

Conventional radiography is considered the most economical method of enabling the assessment of some complications mostly related to the position of the dialysis catheter. Other imaging techniques including CT and MR peritoneography, ultrasonography, peritoneal scintigraphy, and barium studies reportedly have been helpful in evaluating CAPD-related complications.[5,8] Given the increasing population of patients with renal failure who receive treatment and the intensive use of imaging in patients with end-stage kidney disease, the complications of CAPD may become more frequent in the future. MR peritoneography allows for a safe, quick, and easy to perform non-invasive multiplanar imaging evaluation of the peritoneal complications following CAPD, as demonstrated in previous reports and confirmed by our results.[2,13] Drawbacks of this advanced diagnostic imaging procedure, however, include a higher cost and more limited availability than those of other modalities. In our study, MR peritoneography, in correlation with CT peritoneography, proved valuable in the detection of hernias and dialysate leakage. We preferentially perform MR peritoneography in our CAPD patients with suspected complications to eliminate the disadvantages of CT peritoneography—namely, iodinated contrast agents (risk of anaphylactic reactions), exposure to ionizing radiation, and one-plane, axial-only imaging.

Our results indicate that either MR or CT peritoneography proved an undoubtedly valuable tool and accurate imaging technique in those patients treated with peritoneal dialysis, in whom clinical suspicion of CAPD-related complications was raised. Because the safe and uneventful continuation of CAPD depends tremendously on the underlying peritoneal abnormality, peritoneography is to be praised for the non-invasive and time-saving diagnostic properties it affords. We believe that both peritoneographic studies can be used to efficiently select patients who have to be treated conservatively or surgically. In so doing, peritoneography can definitively guide the nephrologist to a switch in renal replacement therapy at the right time that may affect morbidity and mortality of patients with renal failure.

Declaration of conflicting interests

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