Imaging of Peritoneal Catheter Tunnel Infection Using Positron-Emission Tomography

Imaging by ultrasonography or scintigraphy may assist in the diagnosis and management of tunnel infections of the peritoneal dialysis (PD) catheter. Here, we report a case of tunnel infection in which imaging with positron-emission tomography (PET) correctly predicted failure of conservative management.

A 61-year-old man with diabetic nephropathy commenced PD in January 2008. He developed erythema and drainage at the exit site, with negative cultures in February 2008, and frank exit-site infection (ESI) with purulent drainage growing methicillin-sensitive Staphylococcus aureus [MSSA (treated with 3 weeks of oral dicloxacillin)] in August 2008. Subsequently, MSSA-growing purulent drainage from the exit site persisted. Systemic antibiotics were not administered, but there was gradual improvement with gentamicin ointment alone. In November 2008, the patient developed partial extrusion of the outer cuff of the PD catheter. In January 2009, a new ESI developed. Despite a week of treatment with cefazolin and gentamicin, the patient still developed his first episode of peritonitis with coagulase-negative Staphylococcus. He then received intraperitoneal vancomycin with good response.

Although the ESI appeared to have responded to the treatment, PET imaging showed increased fludeoxyglucose (FDG) activity in the whole abdominal wall portion of the PD catheter. The patient resisted removal of the catheter and had no further signs of infection until June 2009. At that time he presented with exuberant inflammatory tissue (“proud flesh”) at the exit site. Repeated PET imaging again showed increased FDG activity along the abdominal wall portion of the catheter. The PD catheter was removed and found to be infected. The patient was placed on temporary hemodialysis.

This case demonstrates that PET imaging, in addition to other imaging techniques, may be useful for diagnosing and managing PD catheter infections.

Key words
Exit-site infection, tunnel infection, positron-emission tomography, tunnel imaging

Introduction
Exit-site infections (ESIs) and tunnel infections of the peritoneal dialysis (PD) catheter are ongoing problems. Exit-site infections are routinely diagnosed by clinical examination (1). Tunnel infections usually occur in the presence of ESIs. Staphylococcus aureus and Pseudomonas aeruginosa ESIs are often associated with concomitant tunnel infections. However, tunnel infections may also occur in the absence of clinically recognized ESIs (2). The presence and the extent of a tunnel infection both affect the management of the infected patient. Peritonitis occurring in a patient with tunnel infection does not usually respond to antibiotic therapy without catheter removal (3). Tunnel infections without concomitant peritonitis can be treated with limited surgical intervention and salvage of the infected catheter (4).

Imaging techniques may be of help in diagnosing tunnel infections (5). Imaging procedures address two questions critical for planning the management of an infection:

- Is a tunnel infection present?
- What is the extent of the tunnel infection along the length of the portion of the catheter within the abdominal wall?
Ultrasonography and scintigraphy with labeled white blood cells (WBCs) have been used for imaging tunnel infections. Here, we present a case of tunnel infection in which positron-emission tomography (PET) with $^{18}$F-fluorodeoxyglucose (FDG) was helpful in defining the management goals.

**Case Report**

A 61-year-old man with diabetic nephropathy, who had been on PD for 1 year, was admitted for treatment of peritonitis in January 2009. Before this admission and since PD catheter placement in December 2007, this patient had had a long history of ESIs. Initially, the exit site lacked any signs of infection. In February 2008, the patient developed erythema and purulent drainage from the exit site. This ESI was treated with 1 g intravenous vancomycin and a 7-day course of oral cephalexin. Exit-site cultures revealed no growth.

In August 2008, purulent drainage from the exit site recurred. Cultures from the site grew methicillin-sensitive *Staphylococcus aureus* (MSSA). The patient did not have any evidence of peritonitis at that time. He was treated with dicloxacillin for a total of 3 weeks. After completion of the course of dicloxacillin, the exit site continued to be erythematous, with open bleeding areas around the site and continuous purulent drainage. New cultures from the exit site again grew MSSA. At that time, antibiotics were not restarted, but continued care of the exit site with gentamicin ointment was maintained.

In a follow-up visit 1 month later, the exit site appeared to be healing, with improvement in erythema. In November 2008, mild protrusion of the external cuff was noted. The exit site appeared dry and without signs of infection at that time.

In January 2009, the patient was admitted with his first episode of peritonitis. Seven days before the admission, he reported erythema around the exit site. Intraperitoneal cefazolin and gentamicin were started at an outside hospital. Exit-site cultures from the outside hospital grew MSSA. On the last day of treatment for the ESI, the patient noted cloudy PD fluid and abdominal pain, and again visited the outside hospital in his home town. Blood and PD fluid cultures were obtained at the outside facility, and he was given 1 dose of intravenous vancomycin. He was then transferred to our hospital for further care.

At presentation, the patient was afebrile with a blood pressure of 150/82 mmHg and a pulse rate of 81. His abdomen was soft, non-distended, with normoactive bowel sounds and mild tenderness to palpation of the right upper and lower quadrants. The exit site was erythematous and indurated, but without drainage. Of 3 blood cultures from the outside hospital, 2 cultures—and the PD fluid culture—grew coagulase-negative *Staphylococcus*. Repeat blood cultures at our hospital were negative. The patient was subsequently started on intraperitoneal vancomycin and was treated for 2 weeks.

An FDG PET scan of the patient’s abdomen disclosed increased FDG activity along the length of the PD catheter tunnel, including both cuffs [Figure 1(A)]. No evidence of peritonitis was present, but the patient had already received several doses of antibiotics at the time that the imaging study was performed.

Removal of the PD catheter was advised. However, the patient, who lives far away from the dialysis unit, declined to consent to catheter removal. Together, the patient and the nephrology team determined that the catheter would continue to be used for PD, but that it would have to be removed if the patient developed another episode of overt catheter-related infection. At a subsequent follow up, that patient showed no signs of ESI or peritonitis.

In March 2009, no drainage or erythema was observed around the exit site. Furthermore, the outer cuff no longer appeared to be exposed.

In May 2009, pus was expressed from the patient’s exit site during a routine PD clinic visit. Cultures from the PD fluid were negative, but the exit-site culture grew MSSA. Thus, the patient was treated with oral cephalexin for 2 weeks. The ESI subsequently resolved after completion of antibiotics.

In June 2009, the patient reported cloudy fluid draining from his PD catheter. The exit site was noted to be indurated and erythematous; it also had evidence of new exuberant tissue (“proud flesh”) growth, indicating a chronic infection. The outer cuff was also fully exposed. The patient was readmitted and started on intravenous vancomycin. The exit site grew MSSA, and the PD fluid contained WBCs (205 cells/mL), but did not grow any organism. Repeated FDG PET imaging showed recurrent or persistent tunnel infection and areas of inflammation through the abdominal wall at each end of the tunnel [Figure 1(B)]. The PD catheter was removed and, on inspection, found to be grossly infected. The patient was treated for 3 weeks with intravenous vancomycin and put on hemodialysis.
A new PD catheter was placed in November 2009 after complete healing of the infected abdominal wound.

**Discussion**

The management of PD catheter infections involves one of three methods:

- conservative management with antibiotics alone,
- management with antibiotics plus minimal surgical intervention (for example, shaving the outer cuff) aimed at saving the catheter, or
- management with antibiotics and removal of the catheter.

To decide on the appropriate management, any question about the presence or the extent of tunnel infection should be cleared. Imaging should be considered if there is uncertainty about either of these two issues.

Ultrasonography has been the imaging modality most commonly employed for diagnosis of PD catheter infections (6–9). A low-echo circumferential rim is seen around the catheter under normal circumstances (5). Tunnel infections produce widening and loss of clarity of the circumferential rim. This area becomes hypoechoogenic, showing fluid collection (10,11). Abscesses can produce larger areas of reduced echotexture. These areas may be similar to those seen with cellulitis, but by compression with the ultrasound transducer, an abscess will be deformable and compressible (2).

Scintigrams using WBCs labeled either with In-111 oxine (12) or with Tc-99m exametazime (13) have also been used to image infected PD catheter tunnels. The use of scintigraphy confirmed that previously reported failures in saving infected PD catheters by shaving the outer cuff (14) were routinely associated with infection of the inner cuff (15).

Imaging by FDG PET has been extensively used in diagnosing and staging tumors. Its second widespread use is in the diagnosis of deep-seated infections. Imaging by FDG PET has proved to helpful in the diagnosis of infected foreign material in the body (such as prosthetic cardiac valves, pacemaker wires, prosthetic joints, aortic grafts, and central venous catheters) and of occult infections in hemodialysis.
vascular access (16). The case presented here illustrates the use of FDG PET imaging in PD catheter infections. In the presence of several imaging methods for PD catheter infections, the choice of method is routinely based on 5 criteria:

- Availability
- Local expertise
- Risks
- Performance
- Costs

The differences between the three techniques are small for the first 3 criteria. Ultrasonography is, in general, available to many institutions at which PD patients are followed. Scintigraphy and FDG PET imaging are less available. A well-trained radiologist and a radiology department with expertise in the relevant technique are indispensable for avoiding diagnostic errors regardless of the technique used. Ultrasonography has no recognizable risks; scintigraphy and FDG PET imaging both have a small risk from exposure to radiation.

The three imaging methods differ substantially in the two last criteria mentioned, however. Despite the larger number of reported studies, the accuracy of ultrasonography in diagnosing PD catheter infections has not been adequately studied. Looking at studies of ultrasonography in other deep-seated infections, it appears that the accuracy of the procedure is not great. For example, one report indicated that the sensitivity of ultrasound in detecting abdominal abscess in patients after colorectal surgery was only 43%; the specificity was 100%, and the overall accuracy was 65% (17). In addition to its low sensitivity, ultrasonography is poor in detecting the extent of deep infections.

Labeled WBC scintigrams may show collections of pus deep in the catheter tunnel in cases in which ultrasonography fails to demonstrate any abnormality around the peritoneal catheter (18). In that report, the sensitivity of In-111 WBC scans in detecting deep tunnel infections was around 70%; the specificity was 100% (18). In another report, a labeled WBC scan had a sensitivity of 83% and a specificity of 75% in diagnosing PD catheter infection (13). An advantage of labeled WBC scans is that they determine the extent of infection along the length of the catheter with accuracy, and they are helpful in the decision to remove the PD catheter (15).

Although the accuracy of FDG PET in diagnosing tunnel infections of the PD catheter will need to be evaluated in future studies, the procedure has been shown to have a high diagnostic accuracy for deep abscesses. In one study of 165 infections in 148 of 248 patients with multiple myeloma, FDG PET identified the site of the infection in 46 episodes in which other imaging methods failed (19). In a meta-analysis of infections in prosthetic joints, the pooled sensitivity of FDG PET in diagnosing those infections was 82.1%; the specificity was 86.6% (20). In the case reported here, FDG PET imaging was accurate both in diagnosing the tunnel infection and in determining its extent.

The costs of imaging procedures vary by geographic area in the United States. In New Mexico, Medicare pays $121.24 for ultrasonography, $1065.54 for WBC scans, and $1350.82 for FDG PET scans with computed tomograms. Thus the choice of imaging technique for a tunnel infection of the PD catheter appears to be between a cheaper but relatively inaccurate method (ultrasonography) and one of two accurate but expensive methods (scintigraphy, FDG PET).

Conclusions
Imaging by FDG PET is an expensive but accurate method of diagnosing deep-seated infection and seems to be useful in tunnel infections of the PD catheter. The case presented here demonstrates that FDG PET imaging can be used to diagnose the presence and extent of PD catheter-related tunnel infections and to guide their treatment.

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References


**Corresponding author:**
Pooja Singh, MD, 1 University of New Mexico, MSC 10-5550, Albuquerque, NM 87131 U.S.A.
**E-mail:**
psingh@salud.unm.edu