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Utility of Peritoneal Scintigraphy in Peritoneal Dialysis Patients: One Center Experience

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Abstract

Background Peritoneal dialysis (PD) is the RRT of choice in 15% of patients with CKD and has multiple advantages over hemodialysis. PD leaks can prompt technique failure and dropout. Use of peritoneal scintigraphy (PS) for diagnosis of PD leaks has declined in favor of more complex and expensive tests. We analyzed the utility of PS for PD leak diagnosis in our center.

Methods We retrospectively analyzed all PS done in our center from January 2000 until December 2018, inclusive, in all patients on PD with a suspected dialysate leak.

Results A total of 39 PS procedures were done in 36 patients on PD in the study period. Of those, 81% were male and 11% had CKD due to polycystic kidney disease. During this period, 23 leaks were diagnosed, showing an incidence of 6% (three episodes per patient per year). In all cases with negative PS, other tests did not confirm a peritoneal dialysate leak.

Conclusions PS is a safe, inexpensive, reproducible, and highly effective diagnostic tool for peritoneal dialysate leaks that allows nephrologists to tailor or stop PD therapy if required. In our opinion, it should be the first-line imaging test to diagnose PD leaks with minimum exposure to radiation, contrast, or other substances that could irritate the peritoneal membrane. We believe PS should be considered as the initial test of choice to diagnose this PD complication as soon as possible, minimizing technique failure and dropout due to leaks.

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Introduction

In the last decades, CKD prevalence has increased up to 10%–13% worldwide, becoming a major health issue with a high economic burden (1). Within RRT, 10%–15% of patients with advanced CKD receive peritoneal dialysis (PD) (2). PD has several advantages such as reduced costs compared with hemodialysis (HD), less hemodynamic instability, and no anticoagulation needs (3,4). The PD technique can have infectious and noninfectious or mechanical complications that may limit PD duration, implying important consequences for morbidity and mortality. Furthermore, up to 20% of patients on PD may end up in technique withdrawal and switch permanently to HD (5).

Of the noninfectious PD complications, leaks occur in up to 5%–10% (6–8), causing dyspnea, apparent ultrafiltration failure, and swelling with intolerable discomfort to the patient. Peritoneal dialysate leaks are defined as the presence of a high glucose fluid anywhere other than in the peritoneal cavity, mostly around the peritoneal catheter (PC), abdominal wall, pleural cavity, and/or genital area. Dialysate leaks are a consequence of the peritoneal membrane integrity loss, either after a surgical intervention, a tear, or a congenital defect. Usually leaks are classified as early if they are detected in the first 30 days after catheter placement, or as late if they are detected after that.

Since the 1970s, complementary tests to diagnose PD leaks have evolved from plain abdominal radiographs to nuclear medicine scans (peritoneal scintigraphy [PS]), computerized tomography (CT) scans, and magnetic resonance imaging (MRI), thus improving their diagnosis. Of the most-used tests, PS is one of the cheapest, safest, and quickest. It is noninvasive, requires minimal radiation exposure (9), and does not need iodinated contrasts or gadolinium.

Despite this, nowadays the use of PS use has declined in favor of more expensive and technically complex imaging tests.

We present or center series of PD leaks diagnosed using PS.

Materials and Methods

Cohort

PD leaks during the study period were identified: all were clinically suspected due to genital or pericatheter

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Table 1. characteristics of patients in our case series (*n*=36)

Characteristics	Measure
Sex (% male)	81
Age (yr)[a]	57.07±15.5
DM (%)	28
BMI >30 kg/m^2 (%)	31
PC inserted by (% nephrologists)	69

DM, diabetes mellitus; BMI, body mass index; PC, peritoneal catheter.
[a]Mean±SD.

edema, shortness of breath with pleural effusion, or a combination thereof. Our unit protocol for dialysate leak diagnosis in PD patients requires a PS.

We retrospectively analyzed all PS done in our center from January 2000 until December 2018, inclusive, in all patients with PD with a suspected dialysate leak. Our center is a tertiary care teaching hospital, attending to a population of approximately 600,000 people in Madrid, Spain.

Patient demographic data on age, sex, cause of ESKD, body mass index (BMI), diabetes status, steroid use, PD catheter insertion technique, and department were collected.

Scintigraphy Technique

Our center protocol for PS technique is as follows: we use 2–3 mCi of the technetium-99m colloidal sterile isotope as tracer diluted in 2 L of 1.36% or 2.27% PD solution (on average). This mixture is administered within 15–20 minutes into the patient's abdomen through the PD catheter by a PD-trained nurse. Afterwards, the usual maneuvers to homogeneously expand PD fluid are done (walking, rolling side to side in supine position) and images are taken using a dual-head γ-camera (Sopha Medical Vision, Twinsburg, OH) with a low-energy, high-resolution, parallel-hole collimator (20% window centered on the 140 keV photopeak of technetium-99m). Static images are acquired at 30 and 120 minutes postinfusion of several projections of the abdomen and lung area, depending on clinical suspicion of the leak site. When needed, delayed images (>120 minutes postisotope infusion) are taken to maximize diagnosis of small leakages and postabdominal voidance.

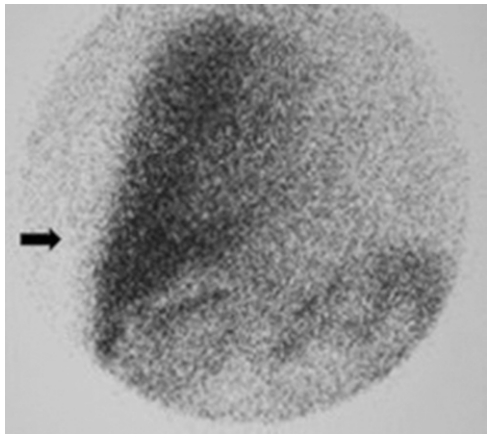

Figure 1. | Peritoneal scintigraphy showing tracer activity in abdomen and right lung area (arrow).

Ethical Standards and Informed Consent

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. This study was approved by the Institutional Review Board at Ramón y Cajal University Hospital (code 087/19). This article does not contain any studies with animals performed by any of the authors.

Because data was retrospectively collected and derived from routine clinical practice, further consents were waived by the Institutional Review Board at Ramón y Cajal University Hospital (code 087/19).

Statistical Analysis

Statistical analysis was performed using the SPSS 20 package (SPSS Inc., Chicago, IL) with significance performed using the *t* test or Mann–Whitney test, and the Fisher exact test for categoric data. Logistic regression analysis was done to evaluate risk factors and confounding variables. Data are reported as mean±SD, median, and range. A *P* value of <0.05 was considered significant.

Results

A total of 39 PS procedures were done in 36 patients on PD in the study period. Of those, 81% were male with a mean age of 52±14.52 years and 20% were women, mean age 61±17.63 years (no statistical significance). The clinical characteristics are shown in Table 1. The PC used was a straight double-cuffed Tenckhoff catheter in all patients, and PCs were inserted by nephrologists in 25 patients (69%) using the minilaparotomy technique (with the deeper cuff inside rectus muscle fascia with purse-string suture of the muscle aponeurosis) in an interventional nephrology suite. Four patients (11%) had CKD due to polycystic kidney disease.

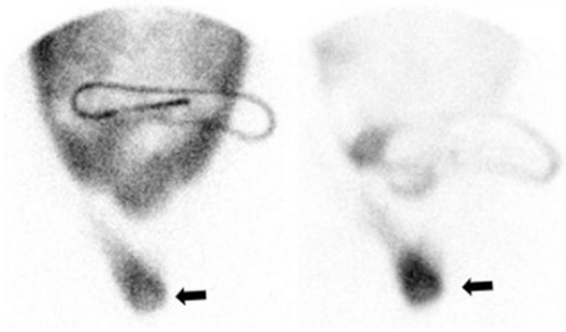

Figure 2. | Peritoneal scintigraphy showing tracer at the abdominal and genital level, confirming a genital leak (arrows).

Leak suspicion was based on clinical signs and symptoms of each patient. PS results were classified into four groups according to suspicion of leak site, as follows.

- Pleural: 15 cases, with positive PS in five (Figure 1). In another two cases, combined pleurogenital leak was suspected, both with negative PS.
- External genitals: eight patients, all with positive PS (Figure 2). In another three patients, combined genital and abdominal wall leak was suspected, with positive PS in all of them (one with abdominal leak confirmed but not genital).
- Abdominal wall: eight cases, with positive PS in four. In two of those cases, the imaging technique also showed an associated pericatheter leak.
- Pericatheter: three patients, with positive PS in all cases (Figure 3).

Table 2 summarizes PS results.

From January 2000 to December 2018, our unit had 344 patients on PD (91,585 patients/mo). All patients were trained by the same specialized PD nurse and 96% had a planned start on PD (PD started >4 weeks after PD catheter insertion). The median training period was ten sessions (range 2–28) and 19 days. During this period, 23 leaks were diagnosed, showing an incidence of 6% (0.03 episodes per patient per year). From all leaks, 11% were diagnosed <30 days post-PC implantation and 89% had a late leak (>4 weeks post-PC insertion). Of the late leaks, seven patients had a leak suspicion <30 days after PD therapy start. Median time between PC placement and PS was 7 months (range 0–113 months) and median time between PD start and leak suspicion was 6.9 months (range 6 days to 113 months).

A negative PS ruled out the presence of a PD fluid leak and allowed treating physicians to continue the pertinent workup to diagnose patients. Other tests were carried out as appropriate: in suspected genital leaks, an ultrasound was performed; suspected pleural and abdominal leaks had a plain radiograph (thorax/abdomen), CT scan, and thoracocentesis, as needed. None of these additional tests demonstrated a dialysate leak. Table 3 summarizes further testing done in patients with negative PS results.

All patients with pleuroperitoneal leaks were permanently transferred to HD. All genital leaks were repaired and their patent processus vaginalis closed, these patients resumed PD afterwards without any issues. All patients with abdominal wall leaks spontaneously recovered after switching PD therapy from continuous ambulatory PD to continuous cycler-assisted PD at low volumes. Pericatheter leaks were spontaneously solved after switching PD therapy to low-volume APD.

A multivariate analysis using logistic regression was performed to determine which features at baseline were predictive of a dialysate leak, including those frequently associated in literature (steroid use, high BMI, diabetes status). In our study, none of these factors or sex, underlying primary renal disease, or PD catheter insertion technique were statistically significant factors for developing a leak (P=0.9, 0.08, and 0.9, respectively).

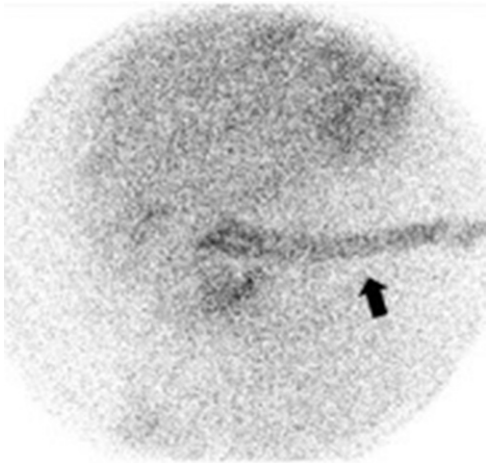

Figure 3. | Peritoneal scintigraphy showing tracer at the pericatheter level (arrow).

Discussion

With an aging society and increasing CKD burden, the need for RRT is rising and patients have more complex issues due to comorbidities and long-standing kidney disease. PD provides good clinical outcomes (10) and helps preserve residual renal function and vascular access capital with few hemodynamic changes (3,4). PD results in a lower cost to the health economy because it requires fewer settings and needs less-qualified staff (11), which is of public importance, and its flexible schedule is less disruptive for patients.

PD complications are relevant due to the important morbidity and mortality they imply: up to 20% of patients may end up in technique withdrawal and switch permanently to HD (5).

Peritoneal dialysate leaks occur in up to 5%–10% (6–8) of patients on PD and its incidence is widely variable between studies, which could be explained by different PC insertion techniques and because most reports usually only refer to a certain leak subtype. Our series, including all leak subtypes and mostly involving the minilaparoscopic PC insertion technique, shows a similar incidence to that described in literature. The presence of dialysate fluid inside the peritoneal cavity increases

Table 2. Clinical suspicion and peritoneal scintigraphy results

Suspected Leak	Total Tested (*n*)	Peritoneal Scintigraphy Result (*n*)	
		Positive	Negative
Pleural	15	5	10
Pleural and genital	2	—	2
External genitals	8	8	—
Genital and abdominal wall	3	3	—
Abdominal wall	8	4	4
Pericatheter	3	3	—
Total	39	23	16

Table 3. Further tests in patients with negative peritoneal scintigraphy results (several tests per patient)

Suspected Leak	Negative PS (*n*)	CT (*n*)	US (*n*)	X-ray (*n*)	Thoracocentesis (*n*)
Pleural	10	9	—	10	7
Pleural and genital	2	2	—	1	—
External genitals	2	2	1	1	—
Abdominal wall	3[a]	1	2	—	—

PS, peritoneal scintigraphy; CT, computed tomography; US, ultrasound.
[a]One patient not studied as had sudden cardiac death.

intra-abdominal pressure and can lead to leaks due to congenital or acquired defects in the abdominal or thoracic wall and/or the diaphragm (12). Known risk factors predisposing to fluid leaks are obesity, long-term steroid use, previous abdominal surgeries, and early use of the PD catheter (13,14). Our study failed to demonstrate an association between some previously identified risk factors like steroid use, BMI >30 kg/m^2, and diabetes status, which could be explained by our small sample size (not powered enough).

Imaging tests to diagnose PD leaks have evolved from plain abdominal radiographs to nuclear medicine scans (PS), CT scans and MRI, thus improving its diagnosis. Of the most-used tests, PS is one of the cheapest (15) and safest, it is noninvasive and requires less radiation (9), no need for iodinated contrasts or gadolinium (both nephrotoxic) that could affect the patient's residual renal function (16), and it is not irritating like methylene blue (17).

Despite this, its use has recently declined in favor of more expensive and technically complex imaging tests. CT scanning and MRI are more expensive (15) (€305 for MRI versus €199 for CT and €150 for PS), with a higher effective radiation dose than PS (almost four times) (9) and delayed images to maximize detection of small leaks are not often feasible, which might make CT scanning/MRI less sensitive than PS for late/small PD leaks.

At present there are several short clinical cases published regarding peritoneal leaks diagnosed using PS (18–20), but only two series published in 1999 and 2006 that have a higher number of patients, with 48 and 17 patients each (16,20) (Table 4); there have been no case series published in the last 10 years. Data on the use of PS in the era of CT scanning are scarce.

We report our center experience from 2000 to 2018 on the use of PS in peritoneal leak suspicion as an inexpensive, reproducible, safe, and equally efficient diagnostic tool than CT and/or MRI. In this study, we demonstrated that no peritoneal leaks were proven among patients with a negative PS test, suggesting that PS is very efficient and is sufficient to rule out peritoneal leaks.

PS also allows late evaluation of leaks without infusing more isotope, which helps to diagnose even small leaks that could otherwise have been overlooked. Keeping in mind that other complex imaging techniques may not be available and provide a higher radiation dose, we believe PS should still be the first diagnostic tool if a dialysate leak is suspected, because it has high sensitivity and diagnostic accuracy. PS is a safe, inexpensive, reproducible, and highly effective diagnostic tool to identify peritoneal dialysate leaks, allowing nephrologists to tailor or stop PD therapy if required. In our opinion, it is the first-line imaging test to diagnose PD leaks with minimal exposure to radiation, contrast, or other substances that could be harmful and irritate the peritoneal membrane. We believe PS should still be the initial test of choice to diagnose this PD complication as soon as possible, minimizing technique failure and dropout due to leaks.

Author Contributions

V. Burguera Vion was responsible for formal analysis; V. Burguera Vion, M. Rivera Gorrín, and R.H. Sosa Barrios provided supervision; M. Fernández Lucas was responsible for validation; M. Rioja Martín and M. Rivera Gorrín conceptualized the study; M. Rioja Martín, M. Rivera Gorrín, and R.H. Sosa Barrios were responsible for methodology; M. Rivera Gorrín was responsible for project administration A. Santos Carreño and R.H. Sosa Barrios were responsible for data curation; A. Santos Carreño was responsible for investigation; R.H. Sosa Barrios wrote the original draft and reviewed and edited the manuscript.

Table 4. Case series of peritoneal scintigraphy in peritoneal dialysis leaks

Case Series	Year Published	PS (*n*)	Patients (*n*)	Cohort on PD (during study period) (*n*)	Study Period (*n*)	Leak Suspicion (*n*)	Positive PS (*n*)	Incidence (%)
Juergensen *et al.* (16)	1999	50	48	204 per yr	1991–1996	34 patients	16	5
Tokmak *et al.* (20)	2006	17	17	—	2000–2004	13	7	5
This study	2020	39	36	344	2000–2018	36	23	6

PS, peritoneal scintigraphy; PD, peritoneal dialysis.

Disclosures

V. Burguera Vion, M. Fernández Lucas, M. Rioja Martín, M Rivera Gorrín, A. Santos Carreño, and R. Sosa Barrios have nothing to disclose.

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