

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

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ABSTRACT

Background: Peritoneal dialysis (PD) is the renal replacement therapy of choice in 15% of patients with chronic kidney disease (CKD), having multiple advantages over haemodialysis. PD leaks can prompt technique failure and dropout. Peritoneal scintigraphy (PS) use in its diagnosis has declined in favour of more complex and expensive tests. We analysed the utility of PS for PD leak diagnosis in our center.

Methods: We retrospectively analysed all PS done in our center from January 2000 until December 2018, both included, in all PD patients with a suspected dialysate leak.

Results: Thirty nine PS procedures were done in 36 PD patients in the study period. Of those, 80.5% were male and 11.1% had CKD due to polycystic kidney disease. During this period 23 leaks were diagnosed, showing an incidence of 6.3% (3 episodes per patient/year). In all cases with negative PS other tests did not confirm a peritoneal dialysate leak.

Conclusion: PS is a safe, inexpensive, reproducible and highly effective diagnostic tool for peritoneal dialysate leaks, allowing 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 initial test of choice to diagnose this PD complication as soon as possible, minimising technique failure and dropout due to leaks.

Keywords: peritoneal dialysis; dialysate leak; renal replacement therapy; scintigraphy; imaging test

INTRODUCTION

In the last decades, chronic kidney disease (CKD) prevalence has increased up to 10-13% worldwide, becoming a major health issue with a high economic burden¹. Within renal replacement therapies (RRT), 10-15% of patients with advanced CKD receive peritoneal dialysis (PD)². PD has several advantages, like reduced costs compared to haemodialysis (HD), less haemodynamic instability and no anticoagulation needs^{3,4} amongst others. PD technique can have infectious and non infectious or mechanical complications that may limit PD duration, implying important morbidity and mortality. Furthermore, up to 20% may end up in technique withdrawal and permanent switch to HD⁵.

Within non infectious PD complications, leaks occur in up to 5-10%⁶⁻⁸, causing dyspnoea, 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 the peritoneal cavity, mostly around the peritoneal catheter, 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 detected in the first 30 days after catheter placement, or late if detected after that.

Since the 70's decade complementary tests to diagnose PD leaks have evolved: from plain abdominal radiographs to nuclear medicine scans (peritoneal scintigraphy), computerized tomography (CT) and magnetic resonance (MR), improving its diagnosis. Within the most used tests, peritoneal scintigraphy (PS) is one of the cheapest, safest and quickest. It is non invasive, implies minimal radiation exposure⁹ and does not need iodinated contrasts nor gadolinium.

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

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

PATIENTS & METHODS

Cohort

PD leaks during the study period were identified: all were clinically suspected due to genital or pericatheter edema, shortness of breath with pleural effusion or a mix of the previous. 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, both included, in all PD patients with a suspected dialysate leak. Our center is a tertiary care teaching hospital, attending a population of approximately 600.000 people in Madrid, Spain.

Patient demographic data on age, gender, cause of end-stage renal disease (ESRD), body mass index (BMI), diabetes status, steroid use, PD catheter insertion technique and department were collected.

This study was approved by the Institutional Review Board at Hospital Universitario Ramón y Cajal (code 087/19). As data was retrospectively collected and derived from routine clinical practise, further consents were waived.

Scintigraphy technique

Our center protocol for PS technique is as follows: we use 2-3 mCi of the ^{99m}Tc -colloid sterile isotope as tracer diluted in 2 liters of 1.36% or 2.27% PD solution (in average). This mixture is instilled within 15-20 minutes in the patient's abdomen through the PD catheter by a PD trained nurse. Afterwards, usual manoeuvres to homogeneously expand PD fluid are done (walking, rolling side to side in supine position) and images are taken using a dual-head gamma camera (Sopha Medica Vision, OH, USA) with a low energy, high resolution parallel-hole collimator (20% window centered on the 140 keV photopeak of Tc 99m). Static images are acquired at 30 and 120 minutes post infusion in several projections of the abdomen and lung area depending on clinical leak site suspicion. When needed, delayed images (>120 minutes post isotope infusion) are taken to

maximize diagnosis of small leakages and post abdominal voidance.

Statistical analysis

Statistical analysis was performed using SPSS 20 package (©SPSS Inc., Chicago, IL) with significance performed with t-test or Mann-Whitney test, and Fisher's exact test for categorical data. Logistic regression analysis was done to evaluate risk factors and confounding variables. Data are reported as mean \pm standard deviation (SD), median and range and *p*-value <0.05 was considered significant.

RESULTS

Thirty nine PS procedures were done in 36 PD patients in the study period. Of those, 80.5% were male with a mean age of 52 ± 14.52 years and 19.5% were women, mean age 61 ± 17.63 years (no statistical significance). The clinical characteristics are shown in table 1. Peritoneal catheter (PC) used was a straight double-cuffed Tenckhoff catheter in all patients and PC was inserted by nephrologists in 25 patients (69.4%) using the mini laparotomy technique (with deeper cuff inside rectus muscle fascia with purse-string suture of the muscle aponeurosis) in an interventional nephrology suite. Four patients (11.1%) had CKD due to polycystic kidney disease.

[Table 1. Characteristics]

Leak suspicion was based on clinical signs and symptoms of each patient. PS results were divided depending on suspicion into 4 groups:

- Pleural: 15 cases, with positive PS in 5 (image 1). In another 2 cases combined pleuro-genital leak was suspected, both with negative PS.
- External genitals: 8 patients, all with positive PS (image 2). In another 3 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: 8 cases, with positive PS in 4. In 2 of those cases the imaging technique also showed an associated pericatheter leak.

- Pericatheter: 3 patients, with positive PS in all cases (image 3).

[Figure 1. PS showing tracer activity in abdomen and right lung area (arrow).]

[Figure 2. PS showing tracer at abdominal and genital level, confirming a genital leak (arrows).]

[Figure 3. PS showing tracer at pericatheter level (arrow).]

Table 2 summarizes PS results.

[Table 2. Clinical suspicion and PS results]

From January 2000 to December 2018, both included, our Unit had 344 patients on PD (9158,5 patients/month). All patients were trained by the same specialised PD nurse and 95.7% had a planned start on PD (PD started >4 weeks after PD catheter insertion). The median training period was 10 sessions (range 2-28) and 19 days. During this period 23 leaks were diagnosed, showing an incidence of 6.3% (0.03 episodes per patient/year). From all leaks, 10.8% were diagnosed <30 days post peritoneal catheter implantation and 89.2% had a late leak (more than 4 weeks post PC insertion). Of the late leaks, 7 patients had a leak suspicion less than 30 days after PD therapy start. Median time between peritoneal catheter 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 – 113 months). A negative PS ruled out the presence of a PD fluid leak and allowed treating physicians to continue the pertinent work up to diagnose patients. Other tests were carried out as appropriate: in suspected genital leaks an ultrasound was performed. Pleural and abdominal suspicions had a plain radiograph (thorax/abdomen), CT scan and thoracocentesis, as needed. None of those additional tests demonstrated a dialysate leak. Table 3 summarises further testing done in negative PS patients.

[Table 3. Further tests in negative PS patients (several tests per patient)]

All patients with pleuroperitoneal leaks were permanently transferred to HD, all genital leaks were repaired and their patent processus vaginalis closed, resuming PD afterwards without any issues. All patients with abdominal wall leaks spontaneously recovered after switching PD therapy from CAPD

to CCPD 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 those neither gender, underlying primary renal disease or PD catheter insertion technique were statistically significant factors for developing a leak (p -values 0.9, 0.08 and 0.9 respectively).

DISCUSSION

With an aging society and increasing CKD burden, the need for renal replacement therapy (RRT) is rising and patients are getting more complex due to comorbidities and long standing kidney disease. PD modality provides good clinical outcomes¹⁰ and helps preserving residual renal function and vascular access capital with less haemodynamic changes^{3,4}. It implies less cost to the health economy as it requires lesser settings and lower qualified staff needs¹¹, 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% may end up in technique withdrawal and permanent switch to HD⁵.

Peritoneal dialysate leaks occur in up to 5-10%⁶⁻⁸ of PD patients and its incidence is widely variable between studies, which could be explained by different peritoneal catheter insertion techniques and mostly because most reports only refer to a certain leak subtype. Our series, including all leak subtypes and mostly with minilaparoscopic PC insertion technique, shows a similar incidence to that described in literature. The presence of dialysate fluid inside the peritoneal cavity increases intrabdominal pressure and can lead to leaks due to congenital or acquired defects in the abdominal or thoracic wall and/or the diaphragm¹². Known risk factors predisposing to fluid leaks are obesity, long-term steroid use, previous abdominal surgeries and early use of PD catheter^{13,14}. Our study failed to demonstrate an association between some previously identified risk factors like steroid use,

BMI > 30 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 (peritoneal scintigraphy), computerized tomography (CT) and magnetic resonance (MR), improving its diagnosis. Within the most used tests, peritoneal scintigraphy (PS) is one of the cheapest¹⁵ and safest, being non invasive and implying less radiation⁹, no need for iodinated contrasts nor gadolinium (both nephrotoxic) that could affect the patient's residual renal function¹⁶, and it is not irritating like methylene blue¹⁷.

Despite this, nowadays its use has declined in favor of more expensive and technically complex imaging tests. CT and MR are more expensive¹⁵ (305 euros MR vs 199 CT and 150 PS), with a higher effective radiation dose than PS (almost 4 times)⁹ and delayed images to maximize detection of small leaks are not often feasible, which might make CT/MR scanning less sensitive than PS for late/small PD leaks.

At present there are several short clinical cases published regarding peritoneal leaks diagnosed using PS¹⁸⁻²⁰, but only 2 series with a higher number of patients published in 1999 and 2006 with 48 and 17 patients each^{16,20} (table 4), none in the last 10 years. Data on the use of PS in the era of CT scanning is scarce.

[Table 4. Case series of PS in PD leaks]

We report our center experience since year 2000 on the use of PS in peritoneal leak suspicion as an inexpensive, reproducible, safe and equally efficient diagnostic tool than CT and/or MR. In this study, we demonstrated that no peritoneal leaks were proven among patients with a negative PS test, suggesting that PS is a very efficient test, 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 have otherwise been overlooked. Keeping in mind other complex imaging techniques may not be available and provide higher radiation dose, we believe PS should still be the

first diagnostic tool if a dialysate leak is suspected, as it has high sensitivity and diagnostic accuracy.

CONCLUSION

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, minimising technique failure and dropout due to leaks.

CONFLICT OF INTERESTS DISCLOSURE

Compliance with Ethical Standards:

- This study did not receive any funding.
- Conflict of Interest: all authors declare there are no conflicts of interest.
- Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the Institutional Review Board at Hospital Universitario Ramón y Cajal (code 087/19). This article does not contain any studies with animals performed by any of the authors.
- Informed consent: As data was retrospectively collected and derived from routine clinical practise, further consents were waived by the Institutional Review Board at Hospital Universitario Ramón y Cajal (code 087/19).

AUTHOR CONTRIBUTIONS

R. H. Sosa Barrios: Data curation; Methodology; Supervision; Writing - original draft; Writing - review and editing

M. E. Rioja Martín: Conceptualization; Methodology

V. Burguera Vion: Formal analysis; Supervision

A. Santos Carreño: Data curation; Investigation

M. Fernandez Lucas: Validation

M. Rivera Gorrín: Conceptualization; Methodology; Project administration; Supervision

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Table 1. Characteristics

	n=36
Gender (% male)	80.5
Age (years)*	57.07 ± 15.5
DM (%)	27.7
BMI >30 (%)	30.5
PC inserted by (% nephrologists)	69.4

* Mean ± standard deviation (SD).

Table 2. Clinical suspicion and PS results

SUSPECTED LEAK	n	PERITONEAL SCINTIGRAPHY	
		Positive	Negative
Pleural	15	5	10
Pleuro+Genital	2	-	2
External Genitals	8	8	-
Genital+Abdo wall	3	3	-
Abdominal wall	8	4	4
Pericatheter	3	3	-
TOTAL	39	23	16

Table 3. Further tests in negative PS patients (several tests per patient)

SUSPECTED LEAK	Negative PS	CT	US	Xray	Thoracocentesis
Pleural	10	9	-	10	7
Pleuro+Genital	2	2	-	1	-
External Genitals	2	2	1	1	-
Abdominal wall	3*	1	2	-	-

*One patient not studied as had sudden cardiac death.

Table 4. Case series of PS in PD leaks

	Published	PS	Patients	Cohort in PD (during study period)	Study Period	Leak suspicion (n)	Positive PS	Incidence
Juergensen et al	1999	50	48	204 per year	1991-1996	34 patients	16	4.7%
Tokmak et al	2006	17	17	--	2000-2004	13	7	5.4%
Sosa Barrios et al	2020	39	36	344	2000-2018	36	23	6.3%

Figure 1. PS showing tracer activity in abdomen and right lung area (arrow).

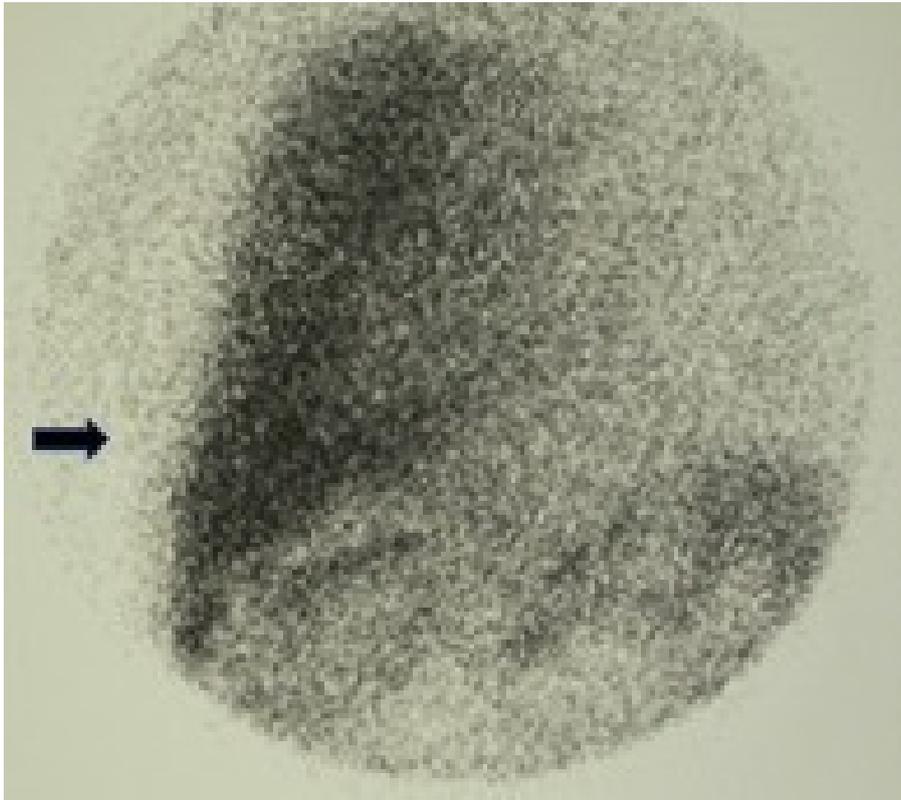


Figure 2. PS showing tracer at abdominal and genital level, confirming a genital leak (arrows).

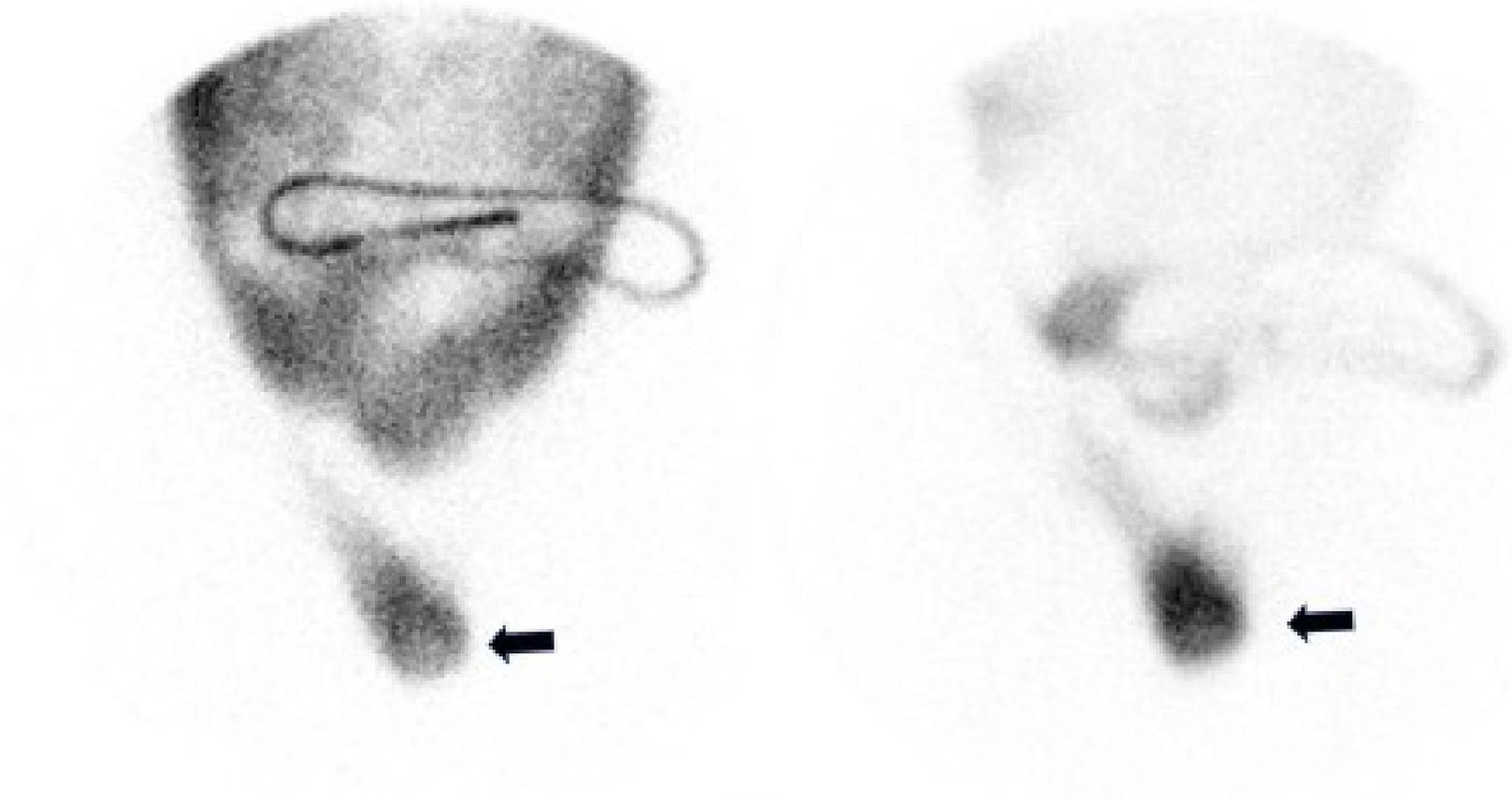


Figure 3. PS showing tracer at pericatheter level (arrow).

