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Bulletin de la Dialyse à Domicile

Non-infectious complications of peritoneal dialysis and peritoneal scintigraphy

(Exploration des complications non infectieuses de la dialyse péritonéale par scintigraphie)

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Résumé

La dialyse péritonéale (DP) est une alternative à l'hémodialyse, indiquée chez les patients en insuffisance chronique terminale. Elle présente de nombreux avantages mais aussi quelques complications, telles que les fuites de dialysat autour du site d'insertion du cathéter, dans la paroi abdominale ou dans la cavité pleurale, les hernies inguino-scrotales ou encore les collections liquidiennes intra abdominales.

La scintigraphie péritonéale est un examen simple, non invasif, peu irradiant, sans risque d'allergie permettant à la fois de diagnostiquer et de localiser ces complications grâce à la possibilité d'acquérir des images au moment de l'infusion mais également à distance et après drainage du dialysat. La tomoscintigraphie couplée au scanner (SPECT/CT : Single Photon Emission Computed Tomography / Computed Tomography) peut également aider à préciser le diagnostic.

L'objectif de cet article est de préciser l'intérêt de la scintigraphie péritonéale dans le diagnostic des complications non infectieuses de la dialyse péritonéale, les conditions de réalisation de l'examen et les indications potentielles, illustrés de quelques cas.

Mots clés : fuite péritonéale, dialyse péritonéale, scintigraphie péritonéale, épanchement pleural,hernie

Summary

Peritoneal dialysis (PD) is an alternative to hemodialysis that is indicated in patients with chronic end-stage disease. It has many advantages, but also complications such as dialysate leaks around the catheter insertion site, in the abdominal wall or in the pleural cavity, inguinoscrotal hernia and even intra-abdominal fluid collection.

Peritoneal scintigraphy is a simple, non-invasive, low-irradiation examination, without the risk of allergy, that allows both diagnosing and locating these complications because it allows acquiring images at the time of infusion, as well as remotely and after drainage of the dialysate. Tomoscintigraphy coupled with scanner SPECT / CT (Single Photon Emission Computed Tomography / Computed Tomography) can also help narrow the diagnosis.

The objective of this article is to clarify the value of peritoneal scintigraphy in the diagnosis of non-infectious complications of peritoneal dialysis, the conditions for performing the examination and the potential indications, as illustrated by a few cases.

Key words : peritoneal leakage, peritoneal dialysis, peritoneal scintigraphy, pleural effusion,hernia

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INTRODUCTION

Peritoneal dialysis (PD) is a renal replacement technique offered to patients with stage 5 chronic renal failure. Despite its potential as an alternative to hemodialysis, it is still underused in some countries.

PD is less expensive than hemodialysis, offers equivalent short-term survival and can be performed at home. In the absence of any contraindication, it is often chosen by the patient after being informed on extrarenal purification techniques or is preferentially proposed in the presence of certain co-morbidities or when the creation of vascular access for hemodialysis is difficult. [1] The dialysate is injected into the peritoneal cavity via a catheter penetrating the anterior wall of the abdomen through the parietal peritoneum and its tip is ideally positioned in the pouch of Douglas. The peritoneum functions as a semi-permeable membrane that allows bidirectional exchanges between the liquid introduced into the peritoneal cavity and the blood flowing through the peritoneal capillaries, leading to diffusive and convective purification of the so-called "uremic" toxins of small molecular weight and effective water-sodium subtraction. Typically, up to 2.5 L of dialysate is infused through a catheter into the peritoneal cavity, which increases intra-abdominal pressure and can cause complications. [2]

Among these complications, dialysate leaks are rarely observed, either early after placing the catheter along its parietal path or, later, through a hernial cavity or even in the pleural cavity in the case of diaphragmatic hernia. These leaks alter the quality of the exchanges by making part of the dialysate unavailable and, undiagnosed, can lead to significant morbidity.

Their appearance usually requires a temporary or permanent interruption of the dialysis technique and sometimes requires surgical correction. It is therefore essential for the practitioner to obtain rapid diagnostic confirmation after clinical suspicion.

Imaging of the peritoneal cavity can be performed by radiography, scintigraphy, ultrasound, MRI (Magnetic Resonance Imaging) and CT (Scanner or Computed Tomography) with intraperitoneal injection of an iodinated contrast product. Abdominal radiography can help detect bowel obstruction, constipation, displacement of the dialysis catheter, pneumoperitoneum and peritoneal calcifications. [1] The benchmark remains CT peritoneography, which has a high detection rate, wide availability and ease of use, thereby making it possible to explore the entire peritoneal cavity. However, it has the disadvantage of requiring exposure to ionizing radiation and the infusion of iodinated contrast agent in a 2 L bag of dialysate 30 min before CT imaging, which poses a potential risk of allergy. Magnetic resonance peritoneography is limited by higher costs and limited availability. It provides excellent soft-tissue contrast and allows a broad assessment of PD-related complications [3]. Ultrasound, which is non-irradiating, can also identify certain complications (collections, peritoneal thickening, peritoneal calcifications, thickening of the small intestine, etc.) but has limitations due to inter-observer variability and lack of sensitivity compared to CT and MRI in certain indications.

First described by Pecoraro et al. in 1985 [4], peritoneal scintigraphy is a non-invasive, low-irradiation examination technique that is readily available and presents a very low risk of allergy. This test has high sensitivity for detecting small volume leaks.

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The most common indications for peritoneal scintigraphy are the presence of dialysate leaks around the catheter insertion site, in the abdominal wall or in the pleural cavity, as well as inguinal hernia and localized fluid collection in the abdominal cavity. [5] According to a study of 66 patients, subclinical inguinal hernias were more frequent (11 cases) and there were only 2 pleural leaks (i.e., frequencies of 16.6% and 3% respectively). [6]

DESCRIPTION OF PERITONEAL SCINTIGRAPHY TECHNIQUE

There is no standardized imaging protocol for peritoneal scintigraphy. The description below is inspired by articles on the subject and our experience. [1,7]

Our objective is to propose a protocol that could be useful to nephrologists, in consultation with their colleagues in Nuclear Medicine. Scintigraphy is an examination that must be performed in Nuclear Medicine.

Principle of the examination

Before starting the exam, the dialysis fluid should be completely drained from the abdominal cavity. The patient should be installed in the supine position and positioned under the camera to produce images centered on the abdomen and diaphragmatic domes.

Choice of radiopharmaceutical

A radiopharmaceutical combines a radioactive isotope with a biological molecule capable of targeting certain organs, tissues or cells in the human body.

Due to the size of the particles, and in order to prevent passage through the peritoneum, the most commonly used radiopharmaceutical is colloidal rhenium sulfide labeled with technetium (99mTc), with a usual dose of 37 to 185 MBq (1 to 5 mCi). Other radiopharmaceuticals can also be used, such as 99mTc-diethylenetriaminepentaacetic acid or albumin macroaggregates labeled with 99mTc. [1.7-10]

Image acquisition

Peritoneal scintigraphy requires a dual-head gamma camera with a parallel-hole, high-resolution, low-energy collimator. The peak energy should be set at 140 keV, with a 20% window. Several types of images can be produced. Dynamic images are acquired immediately after the administration of the radiopharmaceutical for a period ranging from a few minutes to 30 minutes: for example, 60 images of 2 s or 10 seconds per image up to 180 images using a matrix size of 128 × 128 (zoom to 1). Multiple images can then be acquired with a 256 × 256 matrix (zoom to 1) in the anterior, posterior and lateral positions, for example at 30 minutes, 90 minutes, 4 hours or even 24 hours after administration.

Conduct of the exam [11,12,13]

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The radiopharmaceutical should be infused into the peritoneal dialysis solution, then quickly administered into the peritoneal cavity through a catheter. The volume infused varies according to the patient (approximately 2 L). It is necessary to pay attention to the temperature of the liquid. Anterior dynamic acquisition should be performed simultaneously during the infusion phase to assess the passage and distribution of the radiopharmaceutical in the peritoneal cavity.

Anterior and posterior, or even lateral static, images centered on the abdomen should be acquired. If a pleuroperitoneal leak is suspected, anterior and posterior static images centered on the diaphragmatic domes should also be acquired.

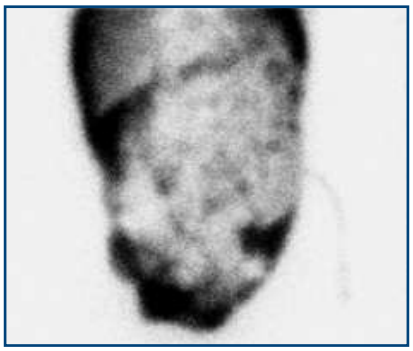
Various physical maneuvers may be required of the patient to promote mixing of the radiopharmaceutical in the peritoneum during the examination period. The patient can also walk for 10 to 15 min.

The advantage of scintigraphy is that it can take late images up to 24 hours after the start of the examination if the first images are inconclusive and a leak is strongly suspected. A scan may be positive after several hours of ambulation due to a slow leak.

Static images should be regularly repeated after ambulation and after drainage of the liquid.

Interpretation of the exam [13]

The dialysate will be distributed throughout the peritoneal cavity [Figure 1]. Typically, dialysate should not be observed in the anterior abdominal wall, pleural cavity, inguinal canal, or in the genital areas. Low tracer activity after drainage of the dialysate may be present.



⬆ *Figure 1. Normal appearance of the diffusion of dialysis fluid containing colloidal rhenium sulfide labeled with technetium (99mTc) into the peritoneal cavity. The catheter is visible to the right of the image*

Traps

It is important to control the distribution of the dialysate in the peritoneal cavity during the infusion by dynamic acquisition. The aim is to control the quality of the exam and to identify abnormal communication. In the case of pleuroperitoneal communication, for example, the accumulation of a significant amount of fluid in the pleural cavity can neutralize the pleuroperitoneal pressure gradient and therefore hinder the migration of the injected radiotracer into the pleural cavity. Acquiring an image after drainage of pleural fluid may be useful. Accidental injection into the gut may render the study non-contributory. [7]

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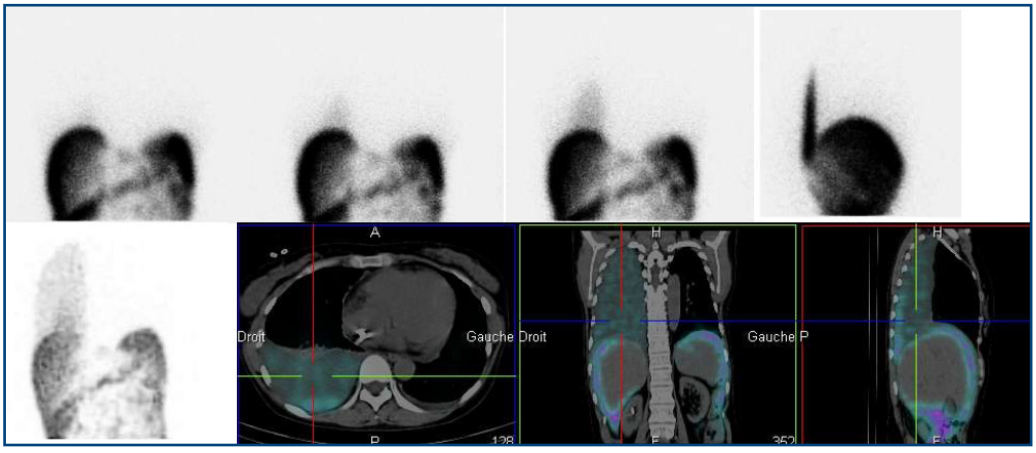
Interest of SPECT and SPECT / CT [14,15,16]

New generations of gamma cameras have made it possible to produce tomographic images (SPECT) that can be coupled to the scanner. (SPECT / CT) These cameras are easily accessible in many departments of Nuclear Medicine and make it possible to increase the sensitivity and specificity of the examination and to ensure better anatomical identification. SPECT / CT acquisition complements planar images, especially if a small leak is suspected, due to better resolution. Intervention can happen at any time during the exam.

INDICATIONS FOR PERITONEAL SCINTIGRAPHY

Leakage into the pleural cavity [17,18] [Figure 2]

A rare but potentially fatal complication of peritoneal dialysis is the leak of dialysate into the pleural cavity, called hydrothorax. Its incidence varies from 2% to 6%, predominates on the right side and preferentially affects women. This complication could be the consequence of a large pressure gradient between the peritoneum and the pleural cavity that causes fluid to pass through areas of acquired or hereditary diaphragmatic fragility. Patients with suspected pleuroperitoneal leakage usually present with dyspnea and tend to have pleural effusions with transudate and elevated glucose levels.



⬆ *Figure 2. 42-year-old female patient with peritoneal dialysis presenting cough with chest pain and right pleural effusion on chest x-ray and CT scan. Peritoneal scintigraphy makes it possible to objectify a leak in the right pleural cavity. (A) Planar images on the anterior face centered on the diaphragmatic domes; (B) Planar image in profile. (C) SPECT / CT*

Harry et al. [18] performed 27 scans and found a pleuroperitoneal leak in 70% of them. The majority of these leaks were detected within 12 minutes of the administration of the tracer, with a strong preponderance of occurrence in the right hemithorax. The major advantage of peritoneal scintigraphy over imaging techniques is that it can detect a slower leak using late images. To treat hydrothorax, discontinuation of PD may be considered for 2 to 6 weeks. Surgery or pleurodesis is reserved for recurrent leaks.

Inguinal or genital leakage and leakage in the abdominal wall [Figure 3]

The infusion of the dialysate causes a significant increase in abdominal pressure, which increases

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linearly with the volume infused and can be responsible for dialysate leakage and hernias. It is estimated that dialysate leakage occurs in more than 5% of patients on PD. An abdominal hernia can develop in about 25% of PD patients. It is more common in patients with polycystic kidney disease, with a history of previous abdominal surgeries and in cases of multiparity, obesity and steroid use [2].

The most common hernias are in the umbilicus, at the catheter insertion site and in the inguinal canal. Dialysate leakage in an abdominal wall hernia may also extend to the scrotum along Scarpa's fascia, at the lower part of the anterior abdominal wall. [1.19]

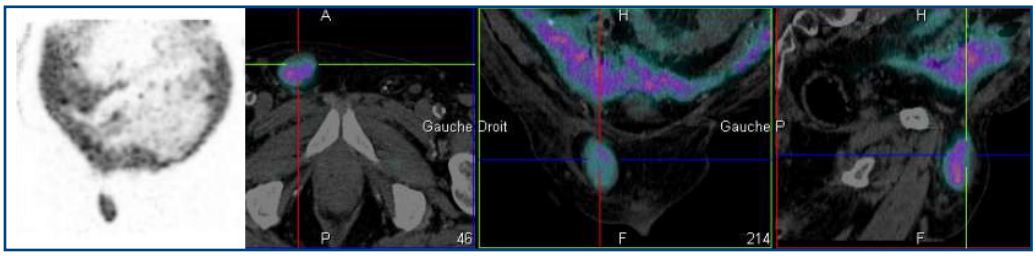

Figure 3. 67-year-old patient with repermeabilization of the right peritoneovaginal duct responsible for edema of the scrotum and penis and failure of peritoneal dialysis demonstrated on a SPECT / CT centered on the abdomen and the penis pool

Inguinal or genital hernias may be secondary to the failure to close the vaginalis process, which is an outgrowth of the parietal peritoneum that crosses the abdominal wall into the scrotum in male patients and the labia majora in female patients. In most people, the vaginalis process closes from a few weeks before birth to the first year after birth. The incidence of the process vaginalis in the adult population is 15% to 37% and is more common in men and on the right, due to the later descent of the right testicle than of the left testicle. More rarely, bilateral perineo-scrotal communication may exist with a «Chicken Leg» appearance. [1.20-26]

Localized collection

Encapsulating peritoneal sclerosis is a fortunately rare but formidable complication of PD. Its incidence is variable, ranging from 0.7 to 7.3% according to data in the literature, [27-30] and has a high mortality rate (24% - 60%). [30]

Encapsulating peritoneal sclerosis comes in the form of peritoneal adhesions that can cause encapsulation of the small intestine, which can lead to partial or complete obstruction. On peritoneal scintigraphy, there is a non-uniform distribution of the dialysate. Post-drainage images show incomplete drainage of dialysate with areas of entrapment. [31]

Leakage into the pericardial cavity [1,32-35]

Leakage of dialysate fluid into the pericardial cavity is extremely rare and may result in dyspnea on exertion, orthopnea or cardiac tamponade, as distinct from possible uremic pericarditis, which is more common. Scintigraphy, supplemented by SPECT / CT, can help confirm peritoneopericardial communication by revealing pericardial effusion in a «horseshoe» shape.

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CONCLUSION

Peritoneal scintigraphy may be useful in exploring non-infectious complications of peritoneal dialysis. It is a simple, non-invasive, low-irradiation examination with a low risk of allergy that is useful in the diagnosis of dialysate leaks in the pleural cavity, the abdominal wall or in the inguinoscrotal region. To more easily detect these complications, several images can be taken over time, up to 24 hours after the start of infusion, without additional exposure to radiation, and these can be supplemented by SPECT / CT acquisition to improve sensitivity and the detection and management of these complications.

Disclosure

The authors declare no conflict of interest for this article.

Authors' contribution

Pierre Pascal wrote the article and Marie-Béatrice Nogier reviewed the article and wrote corrections

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