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Review Article

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Pleuroperitoneal Leakage – Is This the End of Peritoneal Dialysis?

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ABSTRACT

Pleuroperitoneal leakage is a rare complication of peritoneal dialysis, emerging as a large, usually right-sided hydrothorax. It is caused by congenital weak points or defects in the diaphragm. The diagnosis is made by the detection of a transfer of dialysate to the pleural cavity by either a dye or contrast-enhanced dialysate. Treatment using peritoneal dialysis pause or pleurodesis is often ineffective, so persistent pleuroperitoneal leakage necessitates termination of peritoneal dialysis in a substantial proportion of the patients. However, video-assisted thoracoscopic surgery with the option of suturing or inserting a mesh is a promising treatment option, which allows for continuation of peritoneal dialysis. Starting with a case vignette, this review provides an overview on pleuroperitoneal leakage and discusses the recent advancements in the treatment of patients with pleuroperitoneal leakage.

Keywords: Hydrothorax, peritoneal dialysis, polypropylenes, surgical mesh, video-assisted thoracoscopy

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INTRODUCTION

The dialysate introduced into the peritoneum can leak into all neighboring regions and structures in peritoneal dialysis (PD) patients. This may be secondary to an interruption or injury to the peritoneal membrane after, for example trauma or surgery, or may be spontaneous. Approximately 5% of all PD patients develop a dialysate leakage during their treatment.[2] Clinically, leakages lead to ultrafiltration failure and weight gain due to resorption of the dialysate while the amount of spent dialysate is greatly reduced. Leakages can be classified according to the time of manifestation.[2] Early leaks occur within 30 days of the start of PD and are based on injuries during the PD catheter implantation or mostly congenital anatomical defects. Late leaks occur after months and are based on weak points in the peritoneum or injuries such as tears after coughing attacks or trauma. The most common sites of leakage are those into the abdominal wall, into the retroperitoneum,[3] or into the groinwhere it manifests itself as an indirect hernia.[4] Compared to very rare locations such as pericardial[5] or vaginal leakage,[6] pleuroperitoneal leakage is far more common.

CASE VIGNETTE

A 71-year-old patient treated with continuous ambulatory PD for 1 year presented to the PD outpatient department with progredient dyspnea.[1] In the days prior, he noticed a reduced drainage and body weight increase. Chest x-ray demonstrated a large pleural effusion on the right side (Figure 1A). After admission to the hospital, pleuroperitoneal leakage was diagnosed by demonstration of the passage of the toluidine blue-stained dialysate into the pleura (Figure 1B). Is this the end of PD in this patient?

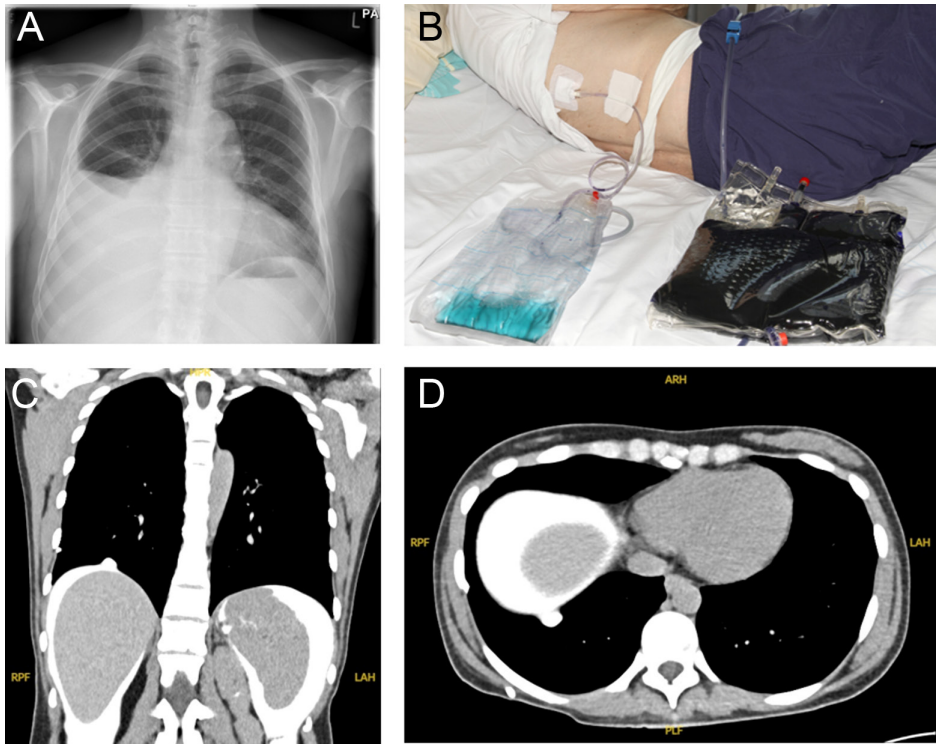

Figure 1. A-D Diagnosis of pleuroperitoneal leakage. (A) Chest x-ray depicting a large right-sided pleural effusion in a 71-year-old PD patient presenting with pleuroperitoneal leakage. (B) Demonstration of leakage of toluidine blue-stained dialysate from the peritoneum to the pleura, detected by a simultaneously inserted small-bore chest tube. (C, D) Leakage appearing as small blebs in a CT scan of another patient after intraperitoneal instillation of the contrast dye. CT, computed tomography; PD, peritoneal dialysis.

HYDROTHORAX IN PERITONEAL DIALYSIS PATIENTS

A right-sided hydrothorax developing in a PD patient was first reported in 1967.[7] In 2 large multicenter studies from Japan with 3195 and 982 PD patients, the incidence was 1.6%[8] and 2.5%,[9] respectively. In 40%-50% of cases, the hydrothorax appeared within the first 2-4 weeks of PD (early form) and 88% affected the right side.[8] The cause of a hydrothorax is mostly the presence of preformed anatomical diaphragmatic defects that lead to pleuroperitoneal leakage under conditions of increased intra-abdominal pressure. A similar pathogenesis is assumed in the formation of hepatic hydrothorax, which occurs in up to 10% of patients with decompensated liver cirrhosis and ascites.[10] Late forms of pleuroperitoneal leakage may occur after trauma or sharp increases in intra-abdominal pressure.[11] Some of these had occurred 8 years after the onset of PD.[8] In our case vignette, the patient was on PD for more than 1 year. Recurrent hydrothorax may lead to termination of PD treatment and require switching the patient to hemodialysis. This affected 46% of all PD patients with hydrothorax.[8]

MAIN POINTS

- Pleuroperitoneal leakage is a rare complication of peritoneal dialysis that often necessitates termination of peritoneal dialysis.
- Pleuroperitoneal leakage is often caused by multiple weak points in the diaphragm.
- Video-assisted thoracoscopic surgery with the option of suturing or inserting a mesh is a promising treatment option, which allows for continuation of peritoneal dialysis.

The most important differential diagnosis of a right-sided pleural effusion in a PD patient is decompensated left heart failure. In addition, pleural effusions caused by pneumonia (parapneumonic or empyema) or a malignant effusion have to be considered.

DIAGNOSTIC APPROACH

The diagnosis of pleuroperitoneal leakage is confirmed by demonstrating the transfer of PD fluid to the pleural cavity. The most common and easiest way is to perform a computed tomography with contrast agent-enhanced dialysate. After taking a native scan, usually 100 mL of an iodine contrast agent are dissolved in 2 L of dialysate and instilled into the peritoneum. A repeat scan is taken 2-3 hours later or immediately upon development of acute dyspnea. A scan at a later stage can be confounded by the diffusion of the contrast agent into the effusion. CT peritoneography has the advantage to visualize the anatomy and to detect blebs in the diaphragm that cause pleuroperitoneal leakage (Figure 2A; also see Matsuoka et al[9]). To increase the diagnostic yield the patient might be asked to strain with maximal breathing.[12] Alternatives are the

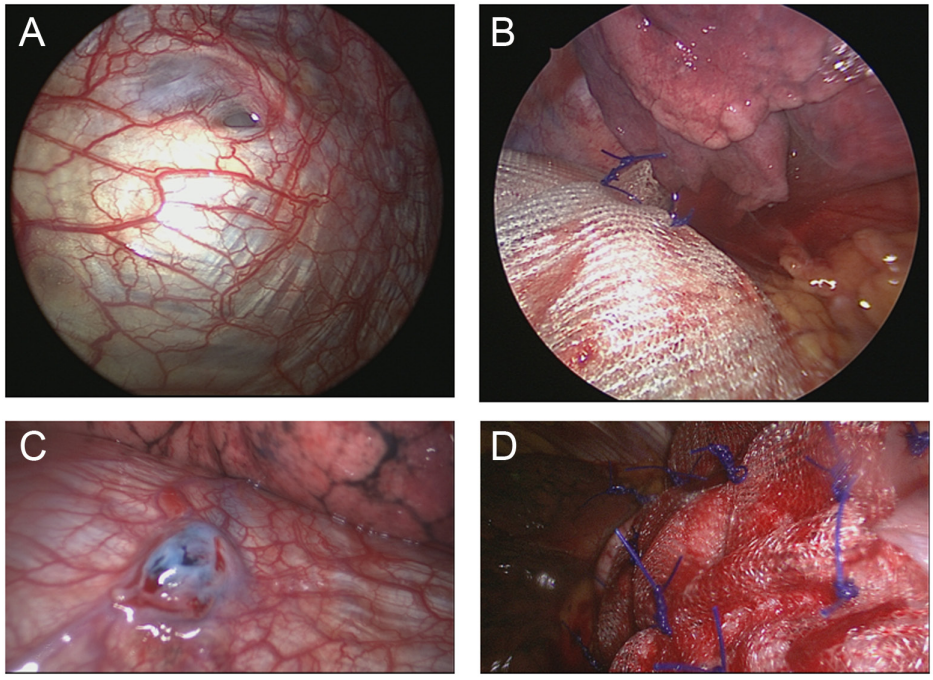

Figure 2. A-D Intraoperative views from video-assisted thoracoscopy. (A) Overview revealing multiple weak points. (B) Image taken after mesh implantation. (C) Higher magnification depicting a small bleb after intraperitoneal instillation of toluidine blue. (D) Image taken after mesh implantation. Taken with permission from.[27]

use of contrast-enhanced sonography[13] or scintigraphic techniques with radioactively labeled albumin or 99m-technetium.[14] Radiological methods have the advantage that they are noninvasive and do not require a pleural puncture to obtain a sample.

Because these pleural effusions are mostly large and have to be relieved by puncture, it is tempting to prove pleuroperitoneal leakage by determining the glucose concentration of the effusion fluid. However, this approach may fail to be diagnostic as the absolute glucose concentration in the fluid may not be clearly increased due to rapid resorption of glucose. Therefore, only high glucose concentrations of >300 or 400 mg/dL may be regarded as diagnostic. In these instances, the calculation of the difference between the glucose concentration in the fluid and the plasma could be diagnostic. In a small study, the cutoff value was found to be a glucose gradient of >50 mg/dL, which was superior to an absolute glucose value.[15] In addition to glucose measurements, determination of the protein concentration can also give strong hints for the presence of pleuroperitoneal leakage. Typically, pleuroperitoneal leakage fluid is almost protein-free and the protein concentration is <0.5 g/dL. In the case vignette, the protein concentration was 0.3 g/dL compared to 6.7 g/dL in the plasma.[1]

In the presence of a large effusion, it might be advisable to insert a small-bore chest drain and to use it to demonstrate the transfer of dialysate after intraperitoneal instillation of toluidine blue (Figure 2B). This approach allows for the detection of pleuroperitoneal leakage occurring slowly, such as overnight leakage. A chemically induced peritonitis has been described in 1 case for the dye methylene blue.[16] In our experience, toluidine blue or methylene blue is poorly tolerated after instillation into the peritoneum, causing sometimes severe abdominal pain and cramps that necessitate the rapid removal of the dye-containing dialysate. As a precaution, only small amounts of the dye should be used.

The most common differential diagnosis is a right-sided pleural effusion in the presence of left heart failure or overhydration. Peritoneal dialysis patients with hydrothorax should therefore undergo echocardiography and determination of fluid status, e.g., by bioimpedance spectroscopy or measurement of the plasma concentration of natriuretic peptides. To exclude malignancy, microscopic analysis of the cellular component of the effusion can be considered as well as contrast-enhanced CT. If suspected, appropriate tests for infectious causes should be complemented (e.g., tuberculosis).

CONSERVATIVE THERAPY

Dialysate leakage can be treated conservatively and/or surgically (Table 1). In the case of conservative therapy, PD is paused to wait for the spontaneous closure of the peritoneal defect. During this time, a temporary switch to hemodialysis may be required. In a study with 104 patients in whom PD was paused for a few weeks to months, PD could be restarted in 53% of the cases, partly with lower filling volumes or automated PD.[17]

Table 1. Overview of the Different Treatment Options for Pleuroperitoneal Leakage (Note That the Evidence for Each Treatment Option Is Very Low)

Treatment	Mode	Advantage	Disadvantage	Evidence	Reference
PD pause	1-4 months	Easy, immediately applicable	Low success rate (~50%)	14 patients 45 patients	9, 17
Pleurodesis	Percutaneously using talcum or tetracycline	No surgery required	High failure rate (termination of PD in 42% of the cases)	33 patients	17
VATS					
	Combined with talcum pleurodesis	PD can be resumed swiftly	Low evidence	9 patients	29
	Suturing of the defects and covering with a resorbable mesh	• PD can be resumed swiftly • Prevention of suture holes	Necessitates intraoperative visualization of the defects	11 patients	9
	Resection of the blebs with a stapler	PD can be resumed swiftly	• Necessitates intraoperative visualization of the defects • Not all blebs can be resected	5 patients	22
	Implantation of a nonresorbable mesh	• Highest reported success rate by induction of large area adhesion • Suturing prevents dislocation	• Bridging with hemodialysis for 3 months required • Possible impairment of diaphragm mobility	12 patients	27

PD, peritoneal dialysis; VATS, video-assisted thoracoscopy.

Since pausing PD has no significant side effects, it is usually the therapy of first choice that can easily be initiated by the treating nephrologist after diagnosis.

Another therapeutic option is chemical pleurodesis, which induces an adhesion of both pleural leaves. Talcum or tetracycline can be used as pleurodesis agents, which are introduced via a thoracic drainage. The success rate for restarting PD was reported to be 48%; this rate also included patients in whom PD pause was initially unsuccessful.[17]

SURGICAL THERAPY USING VIDEO-ASSISTED THORACOSCOPY

In recent years, video-assisted thoracoscopy (VATS) has become the method of choice for treating pleuroperitoneal leakage by closing diaphragmatic defects in adult[18-23] as well as pediatric patients.[24,25] As this procedure is not vitally indicated, the patient's wish to accept the potential risks in favor of continuing PD as the ideal kidney replacement therapy is essential. A VATS-based closure of the pleuroperitoneal leakage can be done either by direct introduction of a pleurodesis agent,

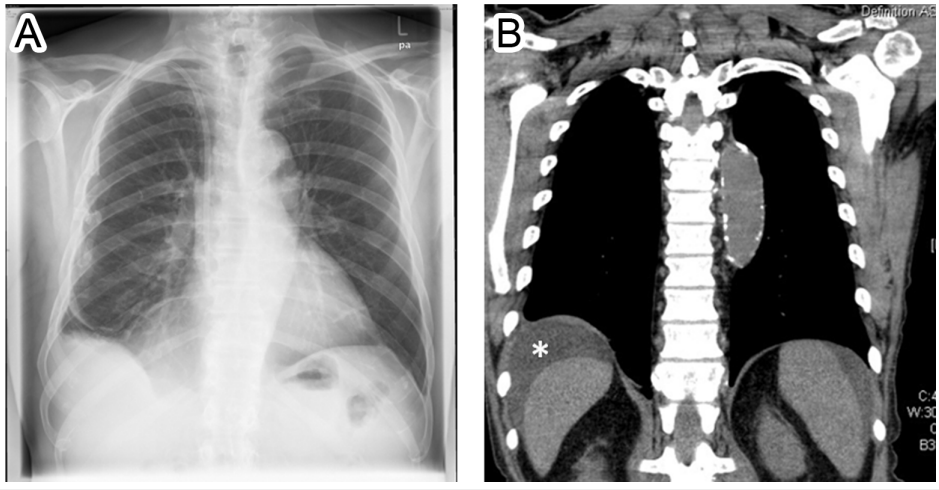

Figure 3. A-B Radiological appearance after VATS with mesh implantation for PL. (A, B) X-ray and CT scan taken after 3 months. Asterisk depicts dialysate in the peritoneum. CT, computed tomography; VATS, video-assisted thoracoscopy. Taken with permission from.[27]

introduction of fibrin glue, or suturing of the defect after visualization. In patients with hepatic hydrothorax, implantation of a nonabsorbable polypropylene mesh, which is sewn from the thoracic side of the diaphragm, is very promising, leading to a success rate of 94% (43 of 47 patients with liver cirrhosis).[26]

The VATS-based mesh implantation for the treatment of pleuroperitoneal leakage was established in the center of the author, starting with the patient from the case vignette.[27] Intraoperatively, there were typically multiple diaphragmatic defects that were closed by implantation and suturing of a mesh (Figure 1C and D). As a result, there is extensive adhesion of the diaphragm to the basal pleura and thus a closure of the leakage. So far, 12 PD patients with pleuroperitoneal leakage from all over Germany have been treated with this method. All patients had developed a right-sided pleural effusion a median of 52 days after onset of PD. In 2 cases the leak even occurred in the second PD year. The median duration of the operation was 97 minutes and many patients had evidence of multiple weak points in the diaphragm. The patients could be discharged after the removal of the chest tube after a median of 5 days. All patients were switched to temporary hemodialysis via a tunneled hemodialysis catheter for a period of 3 months. With the exception of 1 patient with complicated sigmoid diverticulitis, PD could be successfully restarted in all other 11 patients and no recurrence of pleuroperitoneal leakage occurred in any patient over a observation period of 4.4 years.[27] Similar promising results were reported by 2 Japanese case series in 11 and 4 PD patients who were able to resume PD after mesh implantation without recurrence.[9,28] With VATS-supported mesh implantation, there were no postoperative or long-term complications in any case series; in particular, no pulmonary problems were reported. The disadvantage of the method is the fact that it is not widely used so that the patients have to be referred to specialized centers (Figure 3).

CONCLUSION

The hydrothorax as a result of a pleuroperitoneal leak is a rare complication of PD, which leads to the termination of this form of dialysis in half of the cases. If conservative attempts fail, VATS with or without mesh implantation offers excellent success rates and enables continuation of PD.

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