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Case Report

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Pneumoperitoneum in peritoneal dialysis patients; one centre's experience

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Abstract

The pneumoperitoneum (PP) on upright chest X-ray (CXR) usually indicates a perforated viscus. As peritoneal dialysis (PD) catheter provides an additional port of air entry into the peritoneal cavity, the incidence and clinical significance of PP in PD patients has been debated in the literature (a variable incidence from 4 to 34% has been reported in previous studies). With improvement in patient training and connecting devices of PD catheters, technique-related PP is quite rare. Following a recent patient with PP, we reviewed our 3-year data to evaluate the incidence and significance of this radiological sign in PD patients.

We reviewed all upright CXRs in our PD patients from 2006 to 2008, using an electronic radiology database. Over 3 years, we had a total of 156 patients on PD. We have reviewed a total 312 upright CXRs (mean 2 X-rays per patient), which were performed for various clinical reasons during this period.

Seven PD patients had 11 CXRs showing free air under the diaphragm (total incidence of PP 4% of PD population and 3% of CXR performed in PD patients). One patient had two episodes of PP with a total of four X-rays demonstrating free air. Two patients had surgical complications of PD catheter insertion and PP was diagnosed just after the insertion of PD catheter, both of them needed laparotomy. Five patients had incidental PP, which was possibly technique related. In four of these patients with incidental PP, no definite intervention was needed. However, one of these five patients was symptomatic. We established that the cause of PP was faulty technique. Aspiration of PP with a patient in the Trendelenburg position gave her immediate symptomatic relief. We also retrained her to prevent further episodes of PP.

This review demonstrates the quite low and falling incidence of PP (<4% in a prevalent PD population) most likely due to improvement in training and technique. The air should not enter the peritoneal cavity in normal properly performed exchanges. Air under the diaphragm in a PD patient requires appropriate evaluation to exclude visceral perforation. After that, patient technique of PD exchanges should be reviewed. However, if PP persists, aspiration of air can give symptomatic relief.

Keywords: pneumoaspiration; pneumoperitoneum

Background

Peritoneal dialysis (PD) catheter plays a pivotal role in the provision of PD. However, it provides a port of entry for microorganisms into the peritoneal cavity, so peritonitis is one of the commonest complications of PD. Not only the microorganisms but also free air can enter the peritoneal cavity. Presence of free air in the peritoneal cavity is called pneumoperitoneum (PP). Abdominal pain in a patient with a PD catheter *in situ* has many potential differential diagnoses. The pain could be secondary to infection and inflammation of the peritoneum, exit site or tunnel. However, it is important to realize that the pain may not be related to the PD catheter. The surgical causes of abdominal pain, i.e. perforated viscus, remain an important and potentially life-threatening differential diagnosis. Careful clinical evaluation and appropriate investigations are needed to exclude surgical causes of the acute abdomen.

The most common cause of PP in the general population is a perforated abdominal viscus; however, the differential diagnoses are many (see Table 1). Some of the conditions in the table have high mortality and the patient may need surgical intervention.

Incidence and clinical significance of PP in PD patients has been debated widely in the literature [1–4]. Its incidence varies from 4 to 34% as reported in previous studies [1–4]. In some studies, it has been shown that the amount of air under the diaphragm may give clues to the cause of visceral perforation [1, 5] (see Table 2).

It is important to establish the cause of free air in PD patients. Most patients with end-stage chronic kidney disease have multiple comorbidities so surgical exploration to ascertain the cause may pose a significant risk. With improvement in radiological investigation techniques, in most patients, the diagnosis and cause of PP can now be established without surgical intervention. However, in rare cases, exploratory laparotomy may still be indicated. Surgical procedures in these patients carry a risk of losing the PD catheter and loss of the patient's choice of dialysis modality.

One of the causes of PP in a PD patient is related to technique. The management of such a patient is usually symptomatic as the air will be reabsorbed if the technique errors are not repeated. However, in some cases, the patient may develop symptoms with PP and they need more specific measures. Following a recent patient with PP, we reviewed our 3-year data to evaluate the incidence and significance of this radiological sign in our PD patients. We also present a case of successful management of technique-related significant PP.

Methods

We reviewed all upright chest X-rays (CXRs) in our PD patients from 2006 to 2008, using an electronic radiology database called PACS. Most of these CXRs were performed due to reasons other than abdominal pain, the most common being the shortness of breath. The X-ray films were reviewed and verified using the radiology reports. In patients with positive X-rays for PP, the vertical highest column of air was measured under the hemidiaphragm. The case histories of patients with PP were further evaluated.

Table 1. Common causes of PP

Causes of PP
Leakage of air from the gastrointestinal tract
Perforated peptic ulcer
Ruptured diverticulum
Ruptured megacolon (inflammatory or infective)
Carcinoma of the bowel
Bowel anastomosis breakdown
Ischaemic bowel
Necrotizing enterocolitis
Bowel injury due to trauma
Procedure-related PP
After laparotomy
After laparoscopy
Endoscopic bowel injury
After insertion of PD catheter
Air entry during PD
Other causes
Vaginal insufflation
Bronchopleural fistula
Penetrating wounds of the abdomen

In our PD unit, we use double-cuffed tunneled PD catheters with disconnect technique and Y connector. Most of the tubes were inserted under local anesthesia and sedation by the nephrologists. However, in patients with previous abdominal surgery, the tubes were inserted under general anesthesia by the surgeons using minilaparotomy. The training to perform PD was provided by dedicated PD nurses in our unit with particular emphasis on hygiene and prevention of air entry into the circuit. Patients performed PD at home only when they were able to do the PD exchanges independently. They were supervised by the community PD team. If a PD patient developed peritonitis or PP, their technique of PD connections was carefully evaluated and if needed they were retrained.

Results

During 3 years (2006–2008), there were a total of 156 patients (male $n = 89$) in our PD program. Fifty-three percent ($n = 83$) were on automated PD and 47% ($n = 73$) were on continuous ambulatory PD. A total of 312 upright CXRs (mean 2 X-rays per patient) were performed for various clinical reasons during this period. The commonest clinical indication to request CXR was shortness of breath while abdominal pain and preoperative assessment were other two common indications.

Seven patients (4.5% of total population) had 11 X-rays (3.5% of total CXRs performed) showing free air under the diaphragm (Table 3). As this was a total of 3 years of data, in our PD population, the approximate annual incidence of PP diagnosed on upright chest film is ~2%. Based on our data, the probability of the PD patient having PP when a CXR was requested was very low (<1%).

One patient had two episodes of PP with a total of four X-rays demonstrating free air under hemidiaphragm. The reason for performing these X-rays in the index patient was to monitor the size of PP and to correlate it with her symptoms. In four patients with PP, the cause was not clear and the patient remained asymptomatic. The likely possibility in these patients was faulty technique. Two patients (Patient no. 2 and 6 in Table 3) had abdominal pain following the insertion of a PD catheter. One of them (Patient no. 6 in Table 3) had an acute abdomen raising high clinical suspicion of bowel injury. He had laparotomy and removal of

Table 2. Summary and comparison of previous studies and our experience

					Causes and related events			
Author	No. of X-rays	No. of patients studied	Patients with PP, *n* (%)	Episodes of PP	PP with GI perforation, *n* (%)	PP with peritonitis without GI perforation, *n* (%)	Technique related, *n* (%)	Unknown causes, *n* (%)
Lampainen *et al.* [5]	572	74	16 (22)	27	3 (11)	no data	23 (85)	1 (4)
Suresh *et al.* [1]	110	33	7 (21)	9	1 (11)	1 (11)	2 (22)	5 (56)
Kiefer *et al.* [2]	303	101	34 (34)	39	2 (6)	8 (23)	13 (38)	11 (32)
Chang *et al.* [3]	363	75	8 (11)	10	1 (10)	no data	9 (90)	no data
Cancarini *et al.* [4]	403	118	5 (4)	5	no data	1 (20)	5 (100)	
Our study	312	156	7 (4.5)	8 (3.5)	no data	1 (12)	4 (50)	3 (37)

Table 3. Patients with PP in our study

Patient	Sex	No. of X-rays with PP	No. of episodes of PP	Connection system	Air column under diaphragm (mm)	Presumptive cause/management/ outcome
1	Female	1	1	Y-set	2	Cause unknown, managed conservatively
2	Female	1	1	Y-set	3	Cause unknown, managed conservatively
3	Male	1	1	Y-set	4	Post-PD catheter insertion, needed laparotomy and cannula removal
4	Female	2	1	Y-set	94	Faulty technique, patient was symptomatic and air was aspirated with symptomatic relief (see X-rays)
5	Male	1	1	Y-set	6	Cause unknown, managed conservatively
6	Male	1	1	Y-set	2	Post-PD catheter insertion, needed laparotomy and cannula removal
7	Female	4	2	Y-set	60	Cause unknown, managed conservatively

the PD catheter; the surgical team was unable to locate the exact site of bowel injury. Patient no. 2 also had abdominal pain after the PD catheter insertion. He had PP on CXR and was found to have urinary bladder injury on laparotomy. He also lost his PD catheter in the immediate postoperative period.

Case summary of aspiration of PP in a symptomatic patient

One patient was symptomatic (Patient no. 4; see Table 3). She presented with abdominal pain that was worse on eating and defecation and she was not tolerating daytime dwell. PD fluid was clear and she did not have fever. Abdominal examination revealed soft nontender abdomen with upper abdominal fullness and normal bowel sounds. PD fluid Gram staining and culture reports excluded PD peritonitis. CXR showed free air under the right hemidiaphragm (Figure 1: maximum air column 94 mm). She had a surgical review and contrast CT of the abdomen and chest, which excluded visceral perforation. After reviewing her PD technique, we reached a conclusion that the likeliest cause of PP was faulty technique. She was quite symptomatic due to the presence of significant free air inside the peritoneum; we performed pneumoaspiration as described below.

After draining all PD fluid, the patient was placed in the Trendelenburg position. Using a strict aseptic technique and without using any pain relief, we aspirated 250 mL of air until she started feeling a dragging sensation in the abdomen. The repeat CXR (Figure 2) showed a significant reduction in PP. Her symptoms improved and she was able to tolerate the day dwell. Her technique of PD connections was reviewed and she underwent a repeat training.

Fig. 1. CXR showing air under diaphragm in Patient no. 4.

Fig. 2. CXR after aspiration of air in Patient no. 4.

Discussion

With improvement in technology and patient care, most of the complications of PD are falling. Probably some amount of air enters the cavity when the catheter is inserted. This goes undetected as routine CXRs are not done following

catheter insertions. When the patient is started on regular PD, air can enter the peritoneal cavity if appropriate steps are not undertaken by the patient. With a small amount of air, a patient will probably remain asymptomatic and the air will be absorbed. However, if there is significant PP, the patient may get abdominal and other symptoms.

With improvements in PD connecting technology and patient education, the incidence of PP is falling. Lampainen *et al.* [5] in 1986 reported the incidence as high as 16%. Kiefer *et al.* [2] few years later reported the PP incidence as high as 34%.

The other interesting finding is that the incidence of PP secondary to proven viscus perforation has never been reported as high in PD patients, the most likely reason for this could be publication bias. Most of the patients in these previously published studies had PP mainly related to the technique (see Table 2).

After reviewing previous studies and from our clinical observation, we suggest the following steps be used for managing a patient with PP:

(1) A full history and clinical examination of the patient should be performed. Particular attention should be given to catheter insertion, if the patient is symptomatic and with any illnesses, which may predispose the patient to develop gastrointestinal perforation such as diverticular disease. A symtomatic patient immediately after PD catheter insertion should be reviewed by surgeons to exclude possible bowel injury during the catheter insertion. However, if the PP is noted after a week of PD catheter insertion, it is unlikely due to bowel injury.

(2) PD peritonitis should be excluded by performing microbiological tests on PD effluent.

(3) All patients with PP should get appropriate radiological studies, i.e. contrast CT of abdomen. As incidental PP is a rare occurrence, radiological appearance of PP should always be taken seriously.

(4) If the patient has peritonitis associated with PP, a surgical cause is likely and a surgical review is mandatory.

(5) Once surgical causes are ruled out then the PP is most likely due to faulty technique. Careful review of the technique will lead to resolution in most cases.

In a rare situation such as in our patient, if a patient remains symptomatic, aspiration of air under aseptic precautions will lead to immediate symptomatic relief.

Conflict of interest statement. None declared.

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