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RISK FACTORS FOR ABDOMINAL WALL COMPLICATIONS IN PERITONEAL DIALYSIS PATIENTS

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← Background: Patients treated with peritoneal dialysis (PD) have increased intra-abdominal pressure and a high prevalence of abdominal wall complications.
← Objective: The purpose of this study was to determine the incidence of hernias and peritoneal leaks in our PD patients and to investigate their potential risk factors.
← Patients: We studied 142 unselected patients treated with PD during the past 5 years, including those that were already on PD and those that started PD during this period. Mean age was 54 years and mean follow-up on PD was 39 months. 72 patients had been treated with only continuous ambulatory PD (CAPD), 8 with automated PD (APD), and 62 with both modalities.
← Results: 53 patients (37%) developed hernia and/or leak. A total of 39 hernias and 63 leaks were registered. The overall rates were 0.08 hernias/patient/year and 0.13 leaks/patient/year17 patients had both abdominal complications. Hernia was most frequently located in the umbilical region, and the most frequent site of leakage was the pericatheter area. Both complications appeared more frequently during the CAPD period (87% of hernias, 81% of leaks). The rate of hernias was higher in patients treated only with CAPD than in those that used only cyclers [0.08 vs 0.01 hernias/patient/year, not significant (NS)]. No patient treated only with APD had peritoneal leak; 25% (18/72) of patients treated with CAPD developed this complication ($p = 0.18$, NS). Dialysate exchange volumes ranged from 2000 to 2800 mL. 25 (66%) patients required surgical repair of the hernia, with recurrence in 7 patients (28%). 27 (84%) patients with leaks were initially treated with transitory temporary transfer to hemodialysis, low volume APD, or intermittent PD for 4 weeks. The leak recurred in half of the cases and surgical repair was necessary in 12 cases. The development of hernia and/or leak did not correlate with gender, diabetes, duration of follow-up, type of PD, history of abdominal surgery, or with the largest peritoneal exchange volume used. Polycystic kidney disease was the only factor associated with higher rate of hernias ($p = 0.005$), whereas increased age ($p = 0.04$) and higher body mass index ($p = 0.03$) were significantly associated with the appearance of leaks.
← Conclusion: Abdominal hernias and peritoneal leaks are very frequent in the PD population. Advanced age, polycystic kidney disease, and high body mass index are independent risk factors for their development. Automated PD with low daytime fill volume should be considered in all patients at risk for hernias and/or leaks.

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KEY WORDS: Hernia; leak.

Peritoneal dialysis (PD) patients have increased intraperitoneal pressure due to the presence of fill volume in the peritoneal cavity. Intra-abdominal pressure is proportional to the volume infused (1,2). In order to obtain the necessary peritoneal clearances of small solutes, larger dialysate fill volumes are recommended in underdialyzed patients (3). We could expect that, with increasing peritoneal exchange volumes, the risk of abdominal wall complications, such as hernias and leaks, would be higher; however, most reports (4–7) have found no correlation between hernia development and dialysate fill volume.

The purpose of our study was to establish the incidence of hernias and peritoneal leaks in our PD population and to investigate what the risk factors are, their management, and outcome.

PATIENTS AND METHODS

We studied all PD patients treated at our unit between January 1995 and April 2000. Fifty-seven patients were already on PD at the beginning of the study period (January 1995) and 85 began PD during the following 5 years. We analyzed the development of hernias and peritoneal leaks during the entire follow-up period of PD of those patients. Fourteen hernias that developed before entering PD were not included in the study. Five patients underwent

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simultaneous hernia repair and catheter insertion, but those hernias were not included in the study. The cases were identified by chart review. A routine physical examination is always performed at the beginning of PD in order to detect and correct hernias at the time of catheter placement. After that, only clinically evident hernias or those detected because of ultrafiltration failure are diagnosed. Peritoneal catheters were inserted in the paramedian area, over the oblique muscle, under local anesthesia, by a nephrologist using a blind method: The fascia is opened, the muscle is softly separated, and the peritoneum is visualized. The Tenckhoff trocar is then placed over the peritoneum and a perforation is performed with the patient's help tensing the abdominal wall. After the puncture section is removed, the catheter is introduced through the trocar with a metal guide that permits location of the extreme end of the catheter in the opposite iliac fossa. Drainage is confirmed then the fascia is closed. The internal cuff is placed immediately under the fascia and the external cuff is placed 1.5 – 2 cm from the exit site. In our PD unit there are 2 nephrologists that can place peritoneal catheters. Only in specific situations, such as coagulation abnormalities, requirement of concomitant hernia repair, or the presence of abdominal adhesions, is the peritoneal catheter implanted by open surgery. The type of catheter used is straight double-cuff Tenckhoff. Usually, after peritoneal catheter placement we wait at least 3 – 4 weeks until starting PD. Earlier use of the catheter is applied only in those cases in which the patient requires immediate dialysis. In these cases, PD is performed in the supine position with 1.5 L dialysate.

We studied the following variables: age and body mass index (BMI) at the time of starting PD, gender, diabetes, polycystic kidney disease, time of follow-up until withdrawal of PD, type of PD employed during follow-up [continuous ambulatory peritoneal dialysis (CAPD), automated peritoneal dialysis (APD), or both], history of major (gastrectomy, small bowel perforation, hysterectomy) and/or minor (appendectomy, omentectomy, cesarean section) abdominal surgery (prior to or during PD treatment), and the largest peritoneal exchange volume used, including that corrected by body surface area (BSA).

STATISTICAL ANALYSIS

Data are expressed as mean ± SD. A value of $p < 0.05$ was considered statistically significant. Student's t-test was used to compare means and chi-square test was performed to compare proportions. Multivariate logistic regression analysis was used to investigate factors associated with the development of hernia and/or peritoneal leak.

RESULTS

A total of 142 patients (72 men and 70 women) were included in the study. Mean age was 54.3 ± 15 years (range 23 – 87 years); mean follow-up until withdrawal of PD was 38.9 ± 37 months (range 3 – 212 months). Seventy-two patients were treated exclusively with CAPD, 8 patients with APD, and 62 patients with both types of therapy. The cause of renal disease was variable: diabetic nephropathy in 28 patients, chronic glomerulonephritis in 23, unknown in 20, tubulointerstitial nephritis in 18, polycystic renal disease in 17, systemic in 16, nephroangiosclerosis in 15, hereditary in 3, and vascular in 2. Excluding surgical procedures related to hernias and/or repair of leaks, 62 patients underwent abdominal surgery prior to and/or during the PD period. These included 41 major (28 prior to and 13 during PD) and 29 minor (19 prior to and 10 during PD) surgical procedures. Data indicating adequacy of dialysis and nutritional status were within normal range (mean weekly KtV 2.15 ± 0.9, mean protein catabolic rate 1.07 ± 0.4 g/kg/day).

A total of 102 abdominal wall complications (39 hernias and 63 peritoneal leaks) were registered in 37% of the patients (53/142). The overall rates were 0.08 hernias/patient/year and 0.13 peritoneal leaks/patient/year. Twenty-one patients had only hernias, 15 had peritoneal leaks, and 17 suffered both types of complications. General characteristics of patients with and without abdominal wall complications are shown in Table 1.

ABDOMINAL WALL HERNIAS

The type of hernia found was umbilical in 22 cases, incisional in 10, inguinal in 4, and pericatheter in 3. Only 1 patient showed 2 types of hernias (inguinal and pericatheter). Most hernias were clinically asymptomatic. Only 1 patient presented symptoms of small bowel obstruction at diagnosis. The rate of hernias among those patients with history of abdominal surgery was similar to those without previous surgery [0.06/patient/year vs 0.10/patient/year, not significant (NS)]. The mean time from the start of PD to the development of hernia was 16.6 ± 25 months (range 0.1 – 100 months); 8 of the 39 hernias were diagnosed during the first 3 months after starting dialysis. Mean exchange volume when a hernia appeared was 2100 ± 200 mL (range 2000 – 2700 mL): 2000 mL in 30 patients, 2300 in 2, 2500 in 5, and 2700 in 1 (Figure 1). In 2 patients, 3000 mL of exchange volume was used and no hernia developed. Largest fill volume used was similar in patients that developed or did not develop hernias (2279 ± 270 vs 2242 ± 254 mL, respectively, NS), even after correcting for BSA (2244 ± 262 vs 2277 ± 237 mL, NS).

TABLE 1
Comparative Characteristics of Peritoneal Dialysis (PD) Patients With and Without Abdominal Wall Complications

	With abdominal wall complication	Without abdominal wall complication	*p* Value
Patients (*n*)	53	89	
Age (years)	56.8±13.3	52.8±15.4	NS
Male/Female	29/24	43/46	NS
Diabetic	13	21	NS
Polycystic kidney disease	11	7	<0.05
Duration of follow-up (months)	38.2±29	39.2±42	NS
Type of PD			
CAPD	28	44	
APD	1	7	
Both	24	38	
Height (cm)	162.6±9	162.7±8	NS
Weight (kg)	70.3±13	64.5±10.6	<0.01
Body mass index (kg/m^2)	26.6±5.4	24.5±3.8	<0.01
BSA (m^2)	1.77±0.2	1.69±1.6	<0.05
Largest fill volume (mL)	2296±278	2226±242	NS
Largest fill volume (adjusted for BSA) (mL/m^2)	2255±264	2277±232	NS

NS = not significant; CAPD = continuous ambulatory PD; APD = automated PD; BSA = body surface area.

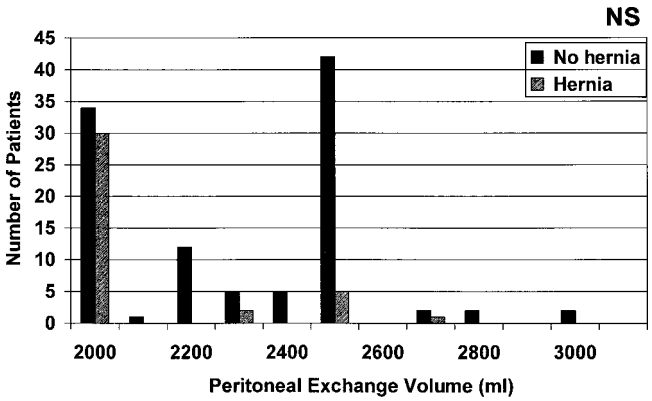

Figure 1 — Correlation between development of hernia and exchange fill volumes. NS = not significant.

A higher incidence of hernias in patients with very small BSA (< 1.675 m^2) has been reported (8). In our PD population (mean BSA 1.72 ± 0.18 m^2, range 1.29 – 2.28 m^2), the rate of hernias (0.05/patient/year) was not significantly different from that of patients with higher BSA (0.10/patient/year, NS).

Nineteen of the 72 (26%) patients that used only CAPD developed hernias after a mean time on PD of 14.8 ± 25 months. In contrast, only 1 of the 8 patients (12%) that used cyclers (p = 0.67, NS) developed hernia after 2 months on PD. However, the mean follow-up of the former patients was significantly longer than that of the latter patients (35.4 ± 25 vs 8.2 ± 4 months, respectively, p < 0.001). When we took into account the different accumulated times of follow-up, the rate of hernias in CAPD patients was higher than in patients treated with APD (0.08 vs 0.01 hernias/patient/year, NS). Thirty-three of the 38 patients (87%) with hernia were being treated with CAPD when the hernia was diagnosed, requiring in 48% of cases (16/33) transfer to APD due to the complication. Twenty-five (66%) hernias were surgically repaired, recurring in 7 patients; the remaining 34% did not require surgical repair because they were small and asymptomatic.

Logistic regression analysis showed autosomal dominant polycystic kidney disease (ADPKD) as the only independent risk factor for development of hernia (p = 0.005). The other variables studied, including peritoneal exchange volume normalized to BSA and history of abdominal surgery, were not determinants (Table 2). Further, after excluding polycystic kidney disease as a factor in a secondary regression analysis, no other variables could be added as determinants.

PERITONEAL LEAKS

The most frequent site of leaks was the pericatheter zone (in 17 patients), followed by previous surgical wound in 8, inguinal in 4, and unknown in 3. More than half the patients (17/32, 53%) with peritoneal leaks had more than 1 episode. Mean time from the beginning of PD to the appearance of a peritoneal leak was 20.7 ± 27 months (range 0.1 – 122 months). Six of the 63 peritoneal leaks occurred during the first month (early leaks). The rate of leaks among patients with a history of abdominal surgery was similar to those without surgeries (0.05 vs 0.08/patient/year, NS). None of the patients treated only with APD had peritoneal leaks; 18 of the 72 patients (25%) treated

TABLE 2
Risk Factors for Hernia Development

	Relative risk	95% Confidence interval	*p* Value
Age	1.00	(0.97–1.03)	0.73
Sex	1.20	(0.60–2.71)	0.51
Duration of follow-up	1.00	(0.99–1.01)	0.89
CAPD vs APD	1.03	(0.80–1.33)	0.80
Diabetes mellitus	0.98	(0.40–2.34)	0.96
Polycystic kidney disease	4.28	(1.54–11.8)	0.005
Body mass index	1.03	(0.95–1.11)	0.40
History of abdominal surgery	0.84	(0.39–1.77)	0.64
Largest exchange volume (adjusted for BSA)	0.99	(0.99–1.003)	0.47

CAPD = continuous ambulatory peritoneal dialysis; APD = automated peritoneal dialysis; BSA = body surface area.

with CAPD developed this complication ($p = 0.18$, NS). When we considered the different accumulated periods at risk in CAPD and APD patients (35.4 ± 25 vs 8.2 ± 4 months), the rate of peritoneal leaks was again different in the groups (0.08 vs 0 leaks/patient/year, NS). Eighty-one percent (26/32) had the peritoneal leak while on CAPD; 10 of them (38%) had to be changed to APD due to this complication.

Mean exchange volume in use on appearance of the leak was 2100 ± 224 mL (2000 – 2800 mL): 2000 mL in 26 patients, 2500 in 5, and 2800 in 1. None of the 2 patients in whom 3000 mL was used developed leaks (Figure 2). The largest fill volume used in patients that developed leaks was similar to that used in those that did not develop leaks (2306 ± 271 vs 2236 ± 253 mL, NS), even when it was normalized to BSA (2299 ± 252 vs 2260 ± 241 mL, NS).

Initially, 27 of the 32 patients with peritoneal leaks were treated with 4 weeks of hemodialysis, or low nocturnal fill volume and dry day, or intermittent PD. Five required immediate surgery because an abdominal hernia was also present. The peritoneal leak relapsed in 14 patients; 2 of the patients required surgical repair, the other 12 needed another 4-week cycle for its resolution. Two patients had to be definitively transferred to hemodialysis due to abdominal wall complications.

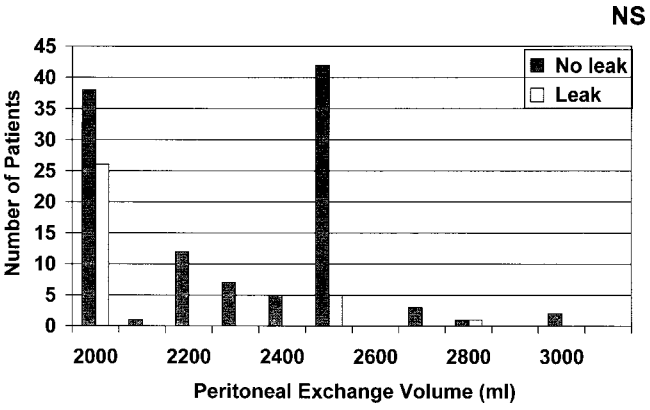

Figure 2 — Correlation between peritoneal leaks and exchange fill volumes. NS = not significant.

On logistic regression analysis, age and BMI were the only independent risk factors for development of peritoneal leak ($p = 0.04$ and $p = 0.03$, respectively). Abdominal surgery and the use of large exchange volumes (normalized to BSA) were not related to development of leaks (Table 3).

DISCUSSION

The incidence of abdominal wall complications, such as hernias and peritoneal leaks, is not related to the exchange fill volume employed. We found an overall rate of 0.08/patient/year and 0.13/patient/year for hernias and peritoneal leaks respectively. The reported prevalence of hernia in PD patients ranges from 9% to 25% in most series (6–12), with an incidence of 0.06 hernias per dialysis year at risk (6). The prevalence of peritoneal leak varies from 1% to 27% (13,14). Some asymptomatic hernias may have been missed because routine screening for hernia detection is not usually performed after PD has been started.

Pressure within the abdomen is increased in PD patients due to the presence of dialysis fluid in the peritoneal cavity, and intra-abdominal pressure rises proportionally to the peritoneal volume infused. In order to improve peritoneal small molecule clearance to obtain the current clinical guideline recommendations on adequacy (3), we usually prescribe larger volumes of dialysate or an increased number of peritoneal exchanges per day. Large exchange volumes are usually well tolerated by the patient (15). There is no agreement on whether increasing the hydrostatic intraperitoneal pressure increases the risk of abdominal wall complications. Durand *et al.* (16) found no more complications with higher pressures, while others (17) observed increased hernia formation when

TABLE 3
Risk Factors for Peritoneal Leak

	Relative risk	95% Confidence interval	*p* Value
Age	1.03	(1.00–1.05)	0.04
Sex	0.96	(0.43–2.11)	0.92
Duration of follow-up	1.00	(0.99–1.01)	0.45
CAPD vs APD	0.93	(0.71–1.22)	0.62
Diabetes mellitus	1.62	(0.67–3.90)	0.27
Polycystic kidney disease	1.88	(0.64–5.50)	0.24
Body mass index	1.09	(1.00–1.19)	0.03
History of abdominal surgery	0.80	(0.36–1.78)	0.59
Largest exchange volume (adjusted for BSA)	1.00	(0.99–1.00)	0.41

CAPD = continuous ambulatory peritoneal dialysis; APD = automated peritoneal dialysis; BSA = body surface area.

the abdominal wall pressure was higher. Moreover, no increase in abdominal wall complications was seen after exchange volumes were increased (5). In the present study, we also found no correlation between exchange fill volumes and development of hernias or leaks, even when fill volumes were normalized to BSA. In fact, 30 patients had hernias and 26 had peritoneal leaks using 2-L peritoneal exchange volumes, while no patients using 3 L suffered any abdominal wall complication. These findings suggest that intrinsic anatomical defects in abdominal wall structure predisposing to the development of such complications are present.

A higher risk of hernias has been described in patients with ADPKD. Prevalence as high as 45% has been reported (18), and this is expected to increase when PD therapy is started. Modi *et al.* (19) showed a higher prevalence of inguinal hernia in patients with ADPKD treated with CAPD, compared with CAPD patients with other renal diseases. Increased intra-abdominal pressure due to polycystic kidneys or primary collagen anomalies has been postulated as being responsible for hernia formation. In contrast, other authors have found no increased incidence of hernias among patients with ADPKD (20). In the present study, 61% of patients with ADPKD had some type of abdominal wall complication. In addition, multivariate logistic regression analysis showed that ADPKD was the only independent risk factor for the development of hernia.

Our study confirms the findings by Hussain *et al.* (6), which show a lower prevalence of hernias in patients treated with APD compared with those treated with CAPD. We observed a higher rate of hernias in patients treated with CAPD than in those patients that used only cyclers (0.08 vs 0.01 hernias/patient/year, NS). In addition, 33 of the 38 patients developed hernias during CAPD treatment (87%), and only 3 during APD. Furthermore, almost half of our patients (49%, 26/53) had to be transferred from CAPD to APD due to abdominal wall complications (16 due to hernias and 10 due to leaks). The largest fill volume used by both groups of patients was not the cause, since it was similar (2139 ± 225 mL in CAPD vs 2111 ± 145 mL in APD, NS). When only the daytime fill volume was analyzed, significantly higher volumes were used in CAPD patients than in APD patients (2139 ± 225 vs 1362 ± 329 mL, respectively, $p < 0.001$). The higher pressure present in the abdominal cavity while the patient is standing or sitting, compared to the supine position (21), could be responsible for the higher rate of hernias found in our CAPD patients.

Due to the high rate of hernias found in our PD population, we recommend an exhaustive search for hernia in all new PD patients, especially in those diagnosed with ADPKD. Asymptomatic hernia has to be detected before the initiation of PD and repaired during the peritoneal catheter insertion procedure. In patients diagnosed during PD treatment, the hernia must be corrected as soon as possible. In order to avoid recurrences, APD treatment with low daytime exchange volumes must be considered in those patients with previous abdominal wall pathology.

As in previous reports (22), in our series, the pericatheter area was the most frequent site of peritoneal leaks. Considering that the most important factor associated with pericatheter leaks is the misplacement of the deep cuff in the rectus muscle (23), we believe that technical factors may have contributed to some of the leaks in our series. Thus, correct insertion of the deep cuff in the subaponeurotic area has to be considered mandatory. In addition, as suggested by some authors (23,24), we have recently introduced suturing the cuff into the muscular aponeurosis or *in situ* infiltration with fibrin glue of the deep cuff in high-risk patients. Preliminary results are encouraging but a longer follow-up is needed to obtain definitive conclusions. In order to avoid early leaks, a 2-week delay before using a newly inserted

peritoneal catheter is also recommended. This policy diminishes the number of early leaks. A closer follow-up of older patients is also necessary. In this sense, our study confirms that age is a risk factor for abdominal wall complications (23).

In summary, this is a large series confirming some of the previous studies on the development of hernias in PD patients. We found a high incidence of abdominal wall complications in our PD unit, mainly during CAPD treatment, and they were not related to the exchange fill volume employed. Larger peritoneal fill volumes, especially using cycler dialysis, can be safely used in most PD patients, including those with small BSA. In addition, APD treatment should be considered in all high-risk patients, especially in those with ADPKD. This condition is specifically related to the development of abdominal wall complications during PD.

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