Hernia
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ORIGINAL ARTICLE

Hernia repair and simultaneous continuous ambulatory peritoneal dialysis (CAPD) catheter implantation: feasibility and outcome

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Abstract

Background Occurrence of abdominal wall hernias during and before peritoneal dialysis constitutes a pivotal role in treatment discontinuation, failure, and exclusion from this dialysis method. We herein present a single-center experience regarding a one-stage surgical strategy, including hernia repair and simultaneous peritoneal dialysis catheter implantation.

Patients and methods Over a 4-year period, 123 patients underwent peritoneal dialysis catheter implantation and 23 patients (19%) had concomitant abdominal wall hernias and were enrolled in this monocentric prospective study. Data collection included recurrent and new-onset hernias, surgical site infection, 1-year and 2-year catheter survival.

Results In 23 patients, 27 hernia repairs combined with peritoneal dialysis catheter implantation were performed. Median age was 52 years (range, 30–85 years) and 18/23 (78%) patients were male. There were no recurrent hernias and no early surgical site infections. Daily flushing was regularly started on the 1st to 3rd postoperative day. Five patients (22%) developed hernias on other anatomical sites, which required hernia repair and perioperative discontinuation of peritoneal dialysis. After a median follow-up of 37 months (range, 28–87 months), 96% of all implanted catheters were still working.

Conclusion Hernia repair and simultaneous peritoneal dialysis catheter implantation are associated with no recurrent hernias, an early start of peritoneal dialysis, a very low postoperative morbidity and very high 1-year and 2-year catheter survival.

Keywords Peritoneal dialysis · Hernia repair · Recurrent hernia

Introduction

The development of abdominal wall hernias in peritoneal dialysis (PD) patients constitutes a troublesome complication, which is often associated with discontinuation of PD and change to another form of dialysis, mainly hemodialysis (HD). Infusing dialysis fluid into the abdomen on a regular basis causes an elevation of the intraabdominal pressure, which is known to be a risk factor for the development of hernias [1]. This circumstance makes it quite obvious that all patients prior to PD-catheter implantation should be screened for asymptomatic abdominal wall hernias by clinical examination and ultrasonography. Recent and past studies evidenced that patients with chronic renal insufficiency are prone to develop hernias due to various metabolic disorders, which go along with impairment of connective tissue stability [2–4]. In the past, the simultaneous tension-free hernia repair with or without mesh and PD-catheter implantation was reported in a low number of patients to be feasible [2, 5]. Nevertheless, there exists no gold standard either for hernia repair or for the postoperative dialysis regimen in this

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patient subset to reduce the incidence of recurrent hernias. Furthermore, there is no consensus on the optimal perioperative management in patients with symptomatic hernias requiring surgical repair during PD.

We herein present a single-center experience of this dual surgical approach regarding prevalence of recurrent and new-onset hernias; occurrence of infections and non-infections complications and 1-year, 2-year, and overall catheter survival.

Patients and methods

Between 2010 and 2014, all patients who underwent implantation of a PD-catheter at the University hospital of Tuebingen were evaluated. Prior to data collection, the study was approved by the local Institutional Board and ethics committee (Nr.:258/2015/BO2).

Study design and inclusion criteria

Patients who underwent PD-catheter implantation and simultaneous hernia repair between January 2010 and December 2014 were included. Data collection process included two sections. Initially parameters like age, sex, etiology of kidney failure, history of previous operations, number and type of hernia repairs, length of operation, and comorbidities were retrospectively evaluated. The second data collection process was performed by an open interview via telephone to evaluate the following parameters: occurrence of recurrent hernias during PD, new-onset hernias, infectious and non-infectious complications associated with PD, need for catheter change or explantation, listing for kidney transplantation or already performed kidney transplantation.

Hernia repair strategies

Operations were performed under general anesthesia and antibiotic prophylaxis, with cefazolin used in every case. Hernia repair was done prior to PD-catheter implantation and up to two hernias were repaired at once. For those patients presenting with multiple hernias, including bilateral inguinal hernias or more than two hernias in total, a two-staged surgical strategy was planned. If a two-staged procedure was necessary, the PD-catheter was implanted during the first operation. The second operation was scheduled after 4 weeks.

Inguinal hernia

Lichtenstein technique was carried out for all inguinal hernias. In every case, a polyester mesh with a resorbable polylactic acid microgrip technology (Parietene Progrip®, Covidien, Dublin, Ireland) was used. No fixation suture was used. Whenever possible, the peritoneal sacs were not opened but dissected and inverted into the abdominal cavity. Fascial closure with interrupted stitches completed the operation. Drains were not routinely used.

Umbilical hernia

In umbilical hernias, the surgical procedure depended on the diameter of the fascial defect. Defects up to 2 cm were directly closed by interrupted stiches using 1–0 polyfilament and slowly absorbable suture material. In the cases of larger defects, a sublay mesh (Parietex®, Covidien, Dublin, Ireland) was implanted. The mesh was extended at least 5 cm beyond the defect and fixed with interrupted monofilament and non-absorbable suture material on the mesh border without closing the fascial defect. After approximation of the subcutaneous tissue the skin was closed using an absorbable monofilament running suture. Drains were not routinely used.

Incisional hernia

Incisional hernias required in every case mesh implantation on the preperitoneal space (Parietex®, Covidien, Dublin, Ireland). The mesh was extended at least 5 cm beyond the fascial defect. Closure of the underlying peritoneal layer prevented contact of the mesh with the adjacent visceral organs. The mesh was fixed on all borders with interrupted 1–0 polypropylene stitches. Due to the elaborate dissection necessary for adequate mesh placement, drains were routinely used to prevent seromas and hematomas.

PD-catheter implantation

Catheter implantation was always performed after hernia repair. The surgical technique consisted of 12 standardized steps. The Swan Neck Curl Cath Missouri® dialysis catheter (Covidien, Dublin, Ireland) and the Oreopoulos-Zellermann (OZ)-catheter® (Covidien, Dublin, Ireland) were used. The decision in favor of one of the two catheters was made by the nephrologist in charge over the course of the preoperative evaluation in reference to belt-line location, sex, and nutritional state.

Statistics

SPSS ver. 12.0 (SPSS Inc. Chicago, IL, USA) was used for statistical analysis. A $p < 0.05$ was considered as statistically significant, when using the chi-squared test and the *T* test. The chi-squared test was used for nominal variables and the *T* test for continuous variables.

Results

Among the 123 patients who underwent PD-catheter implantation, 27 hernias were diagnosed in 23 patients (19%) prior to operation. The median age was 52 years (range, 30–85 years). Patients who developed a new-onset hernia during PD-treatment were significantly older (49 vs. 64 years; $p = 0.027$). Fifteen patients were male and eight were female. Etiology of end-stage renal disease was heterogeneous and could be broken down into six groups: glomerulonephritis ($n = 7$; 30%), unclear ($n = 6$; 26%), diabetic nephropathy ($n = 3$; 13%), ADPKD (autosomal dominant polycystic kidney disease) ($n = 3$; 13%), hypertensive nephropathy (n = 2; 9%), and analgetica nephropathy ($n = 2$; 9%). The vast majority of patients suffered from hypertension ($n = 19$; 83%). Four patients (17%) suffered from diabetes and another four from coronary heart disease. Five patients (22%) had a history of prior abdominal surgery and in three out of five median laparotomy had been performed. The median body mass index (BMI) was 25.89 kg/m^2. Patients who developed a new-onset hernia during PD tended to have a higher BMI without reaching statistical significance (25.5 vs. 27 kg/m^2; $p = 0.502$) (Table 1).

Three patients had multiple abdominal wall hernias. In one patient, there were a synchronous umbilical and inguinal hernia. In the second patient, there were bilateral inguinal hernias and an umbilical hernia and in the third patient, there was an inguinal and incisional hernia. All other patients presented with just one abdominal wall hernia. The most common type of hernia was umbilical ($n = 16$; 59%) followed by inguinal ($n = 9$; 33%). There was one incisional (4%) and one epigastric hernia (4%).

Median operation time for unilateral inguinal hernia repair and PD-catheter implantation was 113 min and was significantly longer than mesh-free umbilical hernia repair (65 min). Median length of hospital stay was 9 days and depended on the extent of hernia repair procedures and the progress of patient education regarding PD-treatment.

Postoperative dialysis regimen

In all patients, daily flushing with 100–300 ml started on the 1st to 3rd postoperative day. Subsequently, PD accompanied by patient education was started. The PD-regimen was depending on the residual renal function, and therefore there was an urgency of adequate dialysis and peritoneal constitution.

Table 1 Patient characteristics

.Variables	*n* (%)	*p* value
Age (years, median)	52	0.027
No new-onset hernia	49	
New-onset hernia	64	
Sex		
Male	15	
Female	8	
Etiology of renal disease		
Glomerulonephritis	7 (30)	
Unclear	6 (26)	
Diabetic nephropathy	3 (13)	
ADPKD	3 (13)	
Hypertensive nephropathy	2(9)	
Analgetica nephropathy	2(9)	
Comorbidities		
Hypertension	19 (83)	
Diabetes mellitus	4 (17)	
Coronary heart disease	4 (17)	
Prior abdominal surgery		
Laparoscopy	2 (9)	
Laparotomy	3 (13)	
BMI (median; kg/m^2)	25.89	0.502
No new-onset hernia	25.5	
New-onset hernia	27.0	
Hernia characteristics		
Umbilical	16 (59)	
Inguinal	9 (33)	
Incisional	1 (4)	
Epigastric	1 (4)	
Pat. with one hernia	20 (89)	
> One hernia	2 (9)	
> Two hernias	1 (4)	
New-onset hernia characteristic		
Inguinal	3 (60)	
Incisional	1 (20)	
Diaphragmatic	1 (20)	
Recurrent hernia	0 (0)	
Median length of hospital stay (days)	9	
Infectious complications		
SSI	1 (4)	
Peritonitis	4 (17)	
Non-infectious complications		
Dialysate leakage	1 (4)	
One-year and two-year catheter survival	22 (96)	

ADPKD autosomal dominant polycystic kidney disease, *ys* years, *BMI* body mass index, *SSI* surgical site infection, *PD* peritoneal dialysis

Recurrent and new-onset hernias

After a median follow-up of 37 months (range, 28–87 months), no recurrent hernias were detected. In five patients (13%), a new abdominal wall hernia was diagnosed. These hernias developed at anatomical sites, which were clinically unremarkable before initial operation. Hernias were diagnosed between 4 and 15 months after initial operation. There were three umbilical hernias, one inguinal hernia, and one epigastric hernia. Table 2 shows further clinicopathological patients characteristics.

Hernia repair during PD

If new-onset hernias were diagnosed during PD, dialysis was paused for the day of the operation with preoperative complete evacuation of the abdominal cavity. PD was paused for 2–4 weeks and then the preoperative PD-regimen was slowly adapted.

Non-infectious complications

During follow up, there was only one dialysate leak from the catheter implantation site, which occurred directly postoperatively. There was no leakage from the umbilical hernia repair site. Because of an adequate residual renal function, start of PD-treatment was postponed for 2 weeks. Afterward, PD (500 ml/change) was started and the dialysate amount could be quickly raised without further leakage. There were no catheter dysfunctions in terms of decreased dialysate in- or efflux.

Infectious complications

During the early postoperative period, there were no surgical site infections, neither at the site of hernia repair nor at the site of PD-catheter implantation. Five months after unilateral inguinal hernia repair and PD-catheter implantation, one patient developed a deep catheter-associated surgical site infection, which made catheter explantation necessary. Since there were no clinical signs of peritonitis, simultaneous removal and reinsertion of the PD-catheter on the contralateral side was performed. This patient is still performing PD.

After a median follow-up of 37 months (range 28–87 months), four patients (17%) suffered from an episode of peritonitis. In two patients, PD-catheter explantation was necessary. Today one patient is performing hemodialysis (HD) and in the other patient, PD-catheter re-implantation was performed after 8 weeks. In the other two patients, PD was paused for 2 weeks accompanied by systemic and intraperitoneal antibiotic treatment and they are still performing PD.

1-year and 2-year catheter survival

One and two years after simultaneous hernia repair and PD-catheter implantation, 22 PD-catheters (96%) were still working. Even after the end of the follow-up period, the 22 catheters were still working. The only catheter explantation was necessary in a female patient due to catheter-associated peritonitis 16 months after umbilical hernia repair without

Table 2 Patient characteristics with new-onset hernias

Pat. No.	1	2	3	4	5
Age (years)	55	60	59	62	85
Sex (m/f)	m	m	m	f	m
Initial operation	Umbilical hernia repair with onlay-mesh	Lichtenstein operation (right side)	Epigastric hernia repair with onlay-mesh	Umbilical hernia repair without mesh	Umbilical hernia repair without mesh
Operation time (min)	154	104	71	60	53
BMI (kg/m^2)	30.8	24.6	23.9	27.6	28.1
Location of new-onset hernia	Epigastric incisional hernia	Left-sided inguinal hernia	Right-sided inguinal hernia	Abdomino-pleural fistula	Right-sided inguinal hernia
Time point of occurrence after primary operation (months)	15	1	1	15	10
Operative procedure for new-onset hernia	IPOM (intraperitoneal Onlay-Mesh)	Lichtenstein operation	Lichtenstein operation	Thoracoscopic mesh-augmented hernia repair	Lichtenstein operation
Dialysis regimen after hernia repair	Discontinuation of CAPD for 6 weeks and bridging via HD	Daily flushing (500 ml/day); after 14 days initial dialysis regimen	Daily flushing (500 ml/day); after 14 days initial dialysis regimen	Daily flushing (500 ml/day); after 14 days initial dialysis regimen	Switch to automated peritoneal dialysis (aPD)

mesh and PD-catheter implantation. The patient was permanently switched to HD.

Kidney transplantation

Eight patients (35%) were listed for kidney transplantation, but at the end of the follow-up period, none of them had received an appropriate donor organ.

Discussion

In our prospective study, we could demonstrate the feasibility of simultaneous hernia repair and PD-catheter implantation. After a median follow-up of 37 months, there were no recurrent hernias and no early surgical site infections. Furthermore, we could show that this surgical concept is associated with a very high 1-year catheter survival rate of 96%. The only catheter explantation was due to peritonitis and was not associated to the surgical procedures per se. Even after the end of the follow-up period, all but one catheter was working.

The only publications describing this one-timed surgical procedure were published by Nicholson et al. in 1989 [2] and by Garcia-Urena et al. [5] in 2006 with a low number of patients. The rationale for this combined approach is that patients only require one operation and the start of PD can be accelerated, which is most important in patients with highly impaired renal function. In the study from Nicholson et al., 19 patients underwent mesh-based hernia repair and simultaneous PD-catheter implantation and were compared to a group of patients only receiving PD-catheter implantation [2]. Contrary to our results, there were two recurrent hernias (11%) 3 months postoperatively and another three patients suffered from leaking dialysate. Garcia-Urena et al. [5] interrupted PD after hernia repair and simultaneous PD-catheter implantation for 4 weeks and experienced no dialysate leakage, but the rate of new-onset hernias was higher compared to our results (22% (n = 5/23) vs. 36% (n = 7/19)). No information was given whether preoperative ultrasonography of predilection areas for hernia occurrence was routinely performed, as it was in our study population hernia repair strategies were similar to ours [5].

To avoid occurrence of dialysate leakage, "The European best practice guidelines for peritoneal dialysis" recommends low-volume exchanges for 2 weeks postoperatively, irrespective of simultaneous hernia repair [6]. Yang et al. compared early (< 14 days) and late (>14 days) start of PD regarding incidence of leakage and found no statistical difference between both groups [7]. These results further underline the feasibility of our early PD initiation after hernia repair and PD-catheter implantation. The most important technical step during PD-catheter implantation, which is also highlighted by "The European best practice guidelines for peritoneal dialysis", is the fixation of the peritoneal layer to the catheter with a purse string suture [6].

An optimal pre-, intra- and postoperative management of PD-patients includes an adequate preoperative clinical and ultrasonographic examination of anatomical predilections areas for hernia development, as well as selection of the appropriate catheter type and exit location, a clearly defined surgical strategy for PD-catheter implantation and hernia repair, especially in patients with multiple or large hernias and an optimal postoperative teaching program to guarantee a smooth PD. An important cornerstone of postoperative management constitutes risk stratification for recurrent hernias during PD, because apart from infectious complications recurrent hernias can play a pivotal role in PD failure. Garcia-Toledo et al. did not find a correlation between daily infused dialysate (as a parameter for intraabdominal pressure) and occurrence of hernias in 146 patients [3]. The only clinicopathological parameter associated with recurrent hernia during PD was a history of hernias in the past. Furthermore, prior abdominal surgery was not associated with an increased risk for recurrent hernia development. These results are comparable to ours. Del Peso et al. also found no correlation between total dialysate volume and prior abdominal surgery and recurrent hernia development [4]. Not surprisingly the authors found a correlation between BMI and age and occurrence of abdominal wall complications, including dialysate leakage and hernias. Interestingly, 53 of 142 patients developed in total 102 abdominal wall complications. This very high incidence of postoperative complications may be linked to the circumstance that the PD-catheter implantations were not performed by a surgical team. In our study, we also found a trend toward a higher BMI in patients with recurrent hernias (25.5 kg/m^2 vs. 27 kg/m^2) and a higher age (49 years vs. 64 years). Results obtained from the authors mentioned above and from our study suggest that age above 60 years, a higher BMI and a history of prior hernias predispose patients for recurrent hernia development during PD. Nephrologists, surgeons, and the patient should be aware of this risk pattern.

Another important management strategy to avoid PD failure is the dialysis regimen applied after operation for recurrent hernia during PD. Unfortunately the literature is scarce and there is only one retrospective study dealing with this topic. Shah et al. started, like in our study, with daily flushing directly postoperatively and after a median of 2 weeks, PD with a lower volume was performed. After 4 weeks, patients were on their preoperative dialysis regimen [8]. None of the 50 patients included had to be switched to HD. Contrary to our results, after a median of 19.9 months, 13 patients developed recurrent hernias. The predominant hernia type was umbilical hernia and only in half of the patients meshes were used. Maybe this circumstance explains the very high

rate of recurrent hernias. In our study, there were no recurrent hernias after new-onset hernia repair and patients were slowly put on the initial PD-regimen after pausing of the PD for 2–4 weeks.

Another trend in PD-catheter implantation is the laparoscopic approach. The most evident advantages of laparoscopic catheter implantation are that occult hernias, especially in obese patients can be detected and repaired and that catheter positioning can be facilitated, because of optimal visualization of the catheter tip. Therefore the laparoscopic approach can be considered in obese patients and in patients with previous operations in the lower pelvis to guarantee adequate catheter positioning. In our study, no PD-catheter was inserted laparoscopically and as we experienced no catheter dysfunction, we think an open procedure was effective choice based our experience.

Conclusion

We could demonstrate that hernia repair and simultaneous PD-catheter implantation is associated with a very low postoperative morbidity and a very high 1-year and 2-year catheter survival. Surgeons and nephrologists must be aware of patients being at a higher risk for developing new-onset hernias after initial operation, if the patients are obese, older, and suffered from hernias in the past.

Author contribution CT and KT: development of study design, critical review of the manuscript, analysis, and interpretation of data. PH: acquisition of data, drafting of the manuscript, analysis, and interpretation of data. AK and TM: critical review of the manuscript.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Human and animal rights The procedures describes in this study were in accordance with the ethical standards of the responsible committee on human experimentation.

Informed consent Informed consent was obtained from all individual participants included in the study.

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