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ORIGINAL ARTICLE

Analysis of mechanical complications in urgent-start peritoneal dialysis

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Abstract

Background Peritoneal dialysis (PD) is an excellent, but underutilized dialysis technique. Thus, its implementation may depend also on the chance to offer this modality of treatment to patients referred late to the nephologists. This approach has recently been named "urgent-start peritoneal dialysis" (UPD). The main barrier to this practice is represented by the fear of early mechanical complications.

Methods All prevalent patients needing urgent-start PD at our institution between 1 January, 2009 and 31 December, 2019 were included in the study. During this period, 242 peritoneal catheters were inserted in 222 patients. In all patients, an anti-leakage/dislocation suture was made. PD was started within 24 h from catheter placement.

Results The early incidence of leakages, catheter dislocations, omental wrappings, bleedings, peritonitis and exit-site infections was 11/242 (4.5%), 5/242 (2%), 3/242 (1.2%), 2/242 (0.8%), 6/242 (2.5%) and 4/242 (1.6%), respectively. No bowel perforations were observed. Nearly one third of the late complications (13/45; 35.2%) resulted in discontinuation of PD, while one fourth (11/45; 24.4%) required surgical revision. The remaining episodes (21/45; 46.6%) were successfully managed by a conservative approach. The survival of the catheter at 3, 6, 12, 24, 36 and 48 months was 93.6, 91.2, 84.8, 77.4, 65.5 and 59.3%, respectively. The technique survival at 3, 6, 12, 24, 36 and 48 months was 97.2, 94.9, 87.6, 78.9, 66.6 and 60.0%, respectively. The main causes of PD drop-out included infectious complications (36.8%) followed by mechanical complications (17.5%).

Conclusions A tight seal between deep cuff and surrounding tissues (double purse-string technique) in association with a starting low-volume exchange scheme allows to minimize early and late mechanical complication in UPD.

Keywords Urgent start peritoneal dialysis (UPD) · Break-in period · Leakage · Peritoneal catheter survival

Introduction

Despite the many potential benefits, including lifestyle flexibility, preservation of residual kidney function and cost savings, peritoneal dialysis (PD) is greatly underutilized as a treatment for end-stage renal disease (ESRD) [1–4]. Only few countries report a PD prevalence up to 75–80% [5], while in western countries the percentage of dialysis patients treated with PD remains around 10% [6].

A large proportion of patients with ESRD start dialysis in an unplanned manner. Actually, many patients are late referrals requiring prompt initiation of dialysis, and others with stable chronic kidney disease (CKD) have an unpredictable, acute worsening of kidney function resulting in an urgent need for dialysis. As a consequence, at the time of dialysis therapy initiation, up to 60–70% of patients who progress to ESRD do not have a well-defined plan [7].

Starting hemodialysis (HD) with a temporary central venous catheter (CVC) is associated with increased hospitalization rates and mortality due to bacteraemia [8–11]. In late-referral patients HD is usually started via a temporary CVC [4]. In these patients PD is rarely considered a feasible option due to both the lack of experience with creating a functioning PD access and to the absence of standard protocols for managing PD exchanges soon after catheter insertion [12].

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Additionally, catheter displacement and peri-catheter leakage are major concerns when PD is started immediately after catheter placement [13]. For this reason, most dialysis centres start PD after a 2-week break-in period [14].

Thus, PD is an excellent, but underutilized dialysis modality and its success and growth in the future might depend on the ability to offer this modality of treatment to late referral patients [15–17].

This study aimed to verify the efficacy and safety of an urgent-start PD (UPD) program characterized by a break-in period of less than 24 h.

Methods

Participants and study design

We conducted a retrospective cohort study; between 1 January, 2009 and 31 December, 2019 all prevalent, adult peritoneal dialysis (PD) patients at the Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico needing urgent-start PD were included in the study. During this period, 242 peritoneal catheters were inserted in 222 patients; 16 of them underwent a second and 2 of them a third Tenckhoff catheter implantation.

Before catheter placement, demographic and clinical data including age, sex, cause of renal disease, comorbidity conditions, history of abdominal surgery, and body mass index (BMI) were collected. Patients were followed up till the end of the study period, or until discontinuation of PD due to death, renal transplantation or technique failure.

During the follow-up period, we recorded the events of leakage, displacement, hernia, hydrothorax, hydrocele, omental wrapping, exit-site infection (ESI), tunnel infection, peritonitis, bleeding and intestinal perforation. Complications were divided into short- ("early") and long-term ("late"), depending on whether they occurred within or after 1 month from PD catheter placement, respectively. The rate of long term complications was expressed as episodes/patient-years dividing the number of events by the time at risk. The early mechanical complications were excluded from the calculation of this rate.

We calculated technique survival (percentage of patients still on PD at a specific time, censored for non-catheter-related death, renal transplantation and loss to follow-up) and catheter survival curves (percentage of functioning catheters at a specific time, censored for non-catheter-related death, renal transplantation, loss to follow-up, inadequate patient dexterity to be able to continue PD or personal choice to be shifted to HD with a functioning PD catheter). All causes of technique and catheter failure were also reported.

Definitions

Urgent-start peritoneal dialysis was defined as the initiation of PD exchanges within 24 h of PD catheter implantation in patients with at least 1 of the following conditions: (1) symptoms of uraemia (nausea, vomiting, asthenia or uraemic encephalopathy), (2) hypervolemia without pulmonary oedema, (3) hyperkalemia ($K > 6.0$ mmol/L) without electrocardiographic changes that were unresponsive to medical therapy.

Technique failure was defined as any event of patient transfer to HD due to a non-functioning PD catheter or an ineffective surgical replacement of the catheter.

Leakage was defined as the presence of dialysate from the incision wound or from the exit site with swelling of the tunnel.

Catheter dislocation was diagnosed in the presence of poor dialysis fluid outlow confirmed by an abdominal X-ray showing the catheter tip outside the true pelvis. Hernia was defined as a bowel protrusion through a weakness in the abdominal wall musculature (incisional, umbilical or inguinal sites). A bleeding event was defined as blood loss into the dialysate or a haematoma near the wound incision requiring red cell transfusions. Hydrothorax was suspected in the presence of symptomatic or asymptomatic effusions found during a chest radiograph and confirmed by pleural fluid analysis revealing a transudate (protein content less than 1 g/dL) with very high glucose concentration (> 300 mg/dL), while hydrocele was diagnosed in the presence of scrotal/penile oedema in the absence of other causes except for the probable presence of a patent processus vaginalis.

According to the International Society for Peritoneal Dialysis [18], ESI was defined as the presence of purulent discharge, with or without erythema of the skin at the catheter-epidermal interface. Tunnel infection was defined as the presence of clinical inflammation along the catheter tunnel or/and a positive ultrasound exam (hypoechogenic area > 2 mm between the tube or the cuff of the catheter and the surroundings tissues) [19, 20]. Peritonitis was diagnosed when at least two of these conditions were present: (1) clinical features consistent with peritonitis (e.g. abdominal pain and/or cloudy dialysis effluent); (2) dialysis effluent white cell count > 100/μL or > 0.1×10^9/L (after a dwell time of at least 2 h), with > 50% polymorphonuclear cells; and (3) positive dialysis effluent culture [21].

Urgent-start PD program

The urgent start-PD program was selected according to the willingness of the patient and the clinical evaluation of the

physicians at the Nephrology Department. In particular, when patients were being evaluated for PD candidacy, they were asked to report on their living environment and to indicate the support they would or would not have at home. An assessment of visual acuity and manual dexterity was performed at the bedside. Furthermore, the abdomen was examined in order to determine the most suitable catheter placement technique for each patient. Once the initial assessment was completed, a recommendation to initiate dialysis with PD was made, emphasizing the importance of avoiding temporary CVC and the opportunity to reduce the total number of procedures involved with dialysis therapy.

After obtaining informed consent for catheter insertion, as well as long-term PD therapy, a straight Dacron double-cuffed Tenckhoff catheter was placed in all patients using a modified double purse-string technique carried out by an interventional nephrologist. The peculiar suture was made around the inner-cuff at the site of the anterior or posterior rectus sheath in a semi-surgical or surgical procedure, respectively, to create a tight seal between the inner cuff and the adjacent tissues, as described elsewhere [22, 23]. In patients who had undergone previous surgical abdominal wall interventions the catheter was implanted surgically, otherwise semi-surgically. On the day of the operation all patients were in the fasting state. One hour before the manoeuvre they were encouraged to empty their bladder and subsequently were given mild pre-anaesthesia consisting of diazepam 20 drops plus half a vial of atropine sulfate 1 mg/mL intramuscularly. A prophylactic dose of cefazolin 1 g intravenously was given before catheter implantation.

As per general protocol, dialytic treatment was started within 24 h of catheter placement by manual exchange in the recumbent position. Initially, four daily exchanges with a dwell volume of 1 L for 3 days were performed. Starting the fourth day, four daily exchanges with a dwell volume of 1.5 L for 3 days were conducted. On the seventh day the infused volume was titrated upward to 2 L and the number of exchanges were fixed according to the patient's clinical needs.

Statistical analysis

Normally distributed variables are presented as mean ± standard deviation, while nonparametric data are presented as median with interquartile range. Categorical variables are expressed as frequency and percentage. The parametric continuous variables were compared by Student's *t*-test, otherwise, the Mann–Whitney *U*-test was used. Fisher's exact test for 2 × 2 contingency tables and Chi-square analysis for larger tables were used to compare the nominal data. All probabilities were two-tailed, and significance level was set at 0.05 to reject the null hypothesis. Life-table analysis (Kaplan–Meier method) was used to calculate technique and catheter survival at a specific time. The life-table curves were statistically compared using the Logrank test, and the Hazard Ratio was provided with a confidence interval of 95% when appropriate. SPSS version 16.0 [SPSS, Inc, Chicago, IL, USA] software package was used for the statistical calculations.

Results

We analysed 222 patients undergoing Tenckhoff catheter placement. One-hundred forty-eight catheters were positioned semi-surgically whereas 94 were inserted surgically. Characteristics of the 222 patients are shown in Table 1, while the patients' characteristics according to the insertion technique are shown in Table 2 (patients who underwent multiple catheter insertion during the follow-up period were counted more than once). We found no difference in age, mean BMI, follow-up duration, percentage of diabetic patients, or distribution of diabetic nephropathy and polycystic kidney disease in the two technique groups, whereas there was a discrepancy in gender distribution due to the presence of a predominant number of males in the semi-surgical group. The incidence of early catheter-related complications in the semi-surgical and surgical groups is shown in Table 3.

Eleven out of 242 patients (4.5%) developed leakage within 1 month; seven events (4.7%) were observed in the semi-surgical arm, while four (4.2%) occurred in the surgical group ($p = 0.86$). Most leakages were managed conservatively by a short interruption of peritoneal exchanges;

Table 1 Clinical characteristics of 222 peritoneal dialysis patients

	Patients ($n = 222$)
Age years [mean ± SD]	62.1 ± 16.7
Gender male [*n*(%)]	149 (67.1)
Diabetic patients [*n*(%)]	35 (15.8)
BMI kg/m^2 [median (IQR)]	23.6 (21.1–26.3)
Renal disease	
Hypertensive nephropathy [*n* (%)]	59 (26.6)
Glomerulonephritis [(*n*%)]	50 (22.5)
Diabetic nephropathy [*n* (%)]	21 (9.5)
ADPKD [*n* (%)]	19 (8.6)
Multiple myeloma [*n* (%)]	14 (6.3)
Unknown [*n* (%)]	28 (12.6)
Others [*n* (%)]	31 (14.0)
Time on PD months [median (IQR)]	26.5 (12.0–49.7)
CAPD patients [*n* (%)]	195 (87.8)

PD peritoneal dialysis; *CAPD* continuous ambulatory PD; *BMI* body mass index; *ADPKD* autosomal dominant polycystic kidney disease; *IQR* interquartile range

Table 2 Clinical characteristics of two-hundred and forty-two patients receiving Tenckhoff catheter insertion

	Patients ($n=242$)	Semi-Surgical ($n=148$)	Surgical ($n=94$)	*P* value
Age years [mean ± SD]	62.4 ± 15.9	60.9 ± 16.4	64.8 ± 15.0	0.06
Gender male [*n* (%)]	163 (67.3)	113 (76.3)	50 (53.2)	0.0002
Diabetic patients [*n* (%)]	45 (16.5)	23 (14.1)	22 (23.4)	0.13
BMI kg/m^2 [median (IQR)]	23.7 (21.1–26.4)	23.6 (21.2–27.0)	23.7 (20.1–26.1)	0.45
Renal disease				
Hypertensive nephropathy [*n* (%)]	65 (26.9)	41 (27.7)	24 (25.5)	0.71
Glomerulonephritis [(*n*%)]	54 (22.3)	33 (22.2)	21 (22.3)	0.99
Diabetic nephropathy [*n* (%)]	24 (9.9)	13 (8.7)	11 (11.7)	0.46
ADPKD [*n* (%)]	20 (8.3)	12 (8.1)	8 (8.5)	0.91
Multiple myeloma [*n* (%)]	15 (6.2)	7 (4.7)	8 (8.5)	0.23
Unknown [*n* (%)]	31 (12.8)	24 (16.2)	7 (7.4)	
Others [*n* (%)]	33 (13.6)	18 (12.2)	15 (15.9)	
Time on PD months [median (IQR)]	28.2 (14.0–51.5)	30.4 (15.3–52.4)	26.4 (13.1–50.7)	0.37
CAPD patients [*n* (%)]	212 (87.6)	128 (86.4)	84 (89.3)	0.5

PD peritoneal dialysis; *CAPD* = continuous ambulatory PD; *BMI* body mass index; *ADPKD* autosomal dominant polycystic kidney disease; *IQR* interquartile range

Table 3 Incidence of catheter-related complications during the first month following peritoneal catheter insertion

	All ($n=242$)	Conservative	SCR/SO	CR and HD	Semi-surgical ($n=148$)	Surgical (n = 94)	*P* value
Leakage [*n* (%)]	11 (4.5)	9	2	0	7 (4.7)	4 (4.2)	0.86
Catheter dislocation [*n* (%)]	5 (2.0)	2	3	0	3 (2.0)	2 (2.1)	0.96
Omental wrapping [*n* (%)]	3 (1.2)	0	2	1	2 (1.3)	1 (1.1)	0.84
Hernia [*n* (%)]	2 (0.8)	1	1	0	2 (1.3)	0 (0)	0.26
Hydrocele [*n* (%)]	2 (0.8)	1	1	0	2 (1.3)	0 (0)	0.26
Hydrothorax [*n* (%)]	0 (0)	0	0	0	0 (0)	0 (0)	
Peritonitis [*n* (%)]	6 (2.5)	6	0	0	5 (3.4)	1 (1.1)	0.26
Exit site infection [*n* (%)]	4 (1.6)	4	0	0	3 (2.0)	1 (1.1)	0.57
Bleeding [*n* (%)]	2 (0.8)	2	0	0	1 (1.1)	1 (1.1)	0.75
Intestinal perforation [*n* (%)]	0 (0)	0	0	0	0 (0)	0 (0)	

PD peritoneal dialysis; *HD* haemodialysis; *Conservativ*e temporary interruption of PD, cycle of enema, active hernia surveillance or antibiotic therapy; *SCR/SO* simultaneous removal and reinsertion of the catheter, surgical hernia repair or surgical diaphragm repair; *CR and HD* catheter removal and permanent shift to HD

only two patients were successfully managed by removal and reinsertion of the catheter in the same session.

Five out of 242 patients (2%) developed catheter dislocations: three (2%) occurred in the semi-surgical arm and two (2.1%) in the surgical group ($p=0.96$). None of these patients needed to be transferred to HD. In particular, three cases were managed by removal and replacement of the catheter in the same session, while the remaining two were successfully resolved by a cycle of enemas.

During the first month following catheter insertion, three cases of omental wrapping were observed (1.2%); two (1.3%) occurred in the semi-surgical arm and one (1.1%) in the surgical group ($p=0.84$); only one patient was transferred to HD, while the other two were resolved by simultaneous reinsertion and removal of the catheter. Two inguinal hernias and two hydroceles (1.6%) were observed within the first month in the semi-surgical arm ($p=0.26$); one episode of hernia and one of hydrocele were successfully resolved by temporary interruption of the dialytic exchanges, while the remaining two events were fixed by surgical interventions. No early episodes of hydrothorax or bowel perforation were reported. Two episodes of bleeding were observed (0.8%), one (1.1%) in the semi-surgical arm and one (1.1%) in the surgical arm ($p=0.75$). The overall incidence of peritonitis within the first month was 6/242 (2.5%), while the incidence of exit site infections was 4/242 (1.6%). No differences in terms of infectious complications were observed between the two groups (Table 3). No patients requested a change

Table 4 Rate of long-term mechanical catheter complications

	No. of episodes per patient-year	Total episodes (% pts)	Conservative	SCR/SO	CR and HD
Leakage	0	0 (0)	0	0	0
Catheter dislocation	0.012	8 (3.6)	5	1	2
Omental wrapping	0	0 (0)	0	0	0
Hernia	0.031	21 (9.4)	13	6	2
Hydrocele	0.019	13 (5.8)	3	4	6
Hydrothorax	0.004	3 (1.4)	0	0	3

PD peritoneal dialysis; *HD* haemodialysis; *Conservative* temporary interruption of PD, cycle of enema or active hernia surveillance; *SCR/SO* simultaneous reinsertion and removal of the catheter, surgical hernia repair or surgical diaphragm repair; *CR and HD* catheter removal and permanent shift to HD

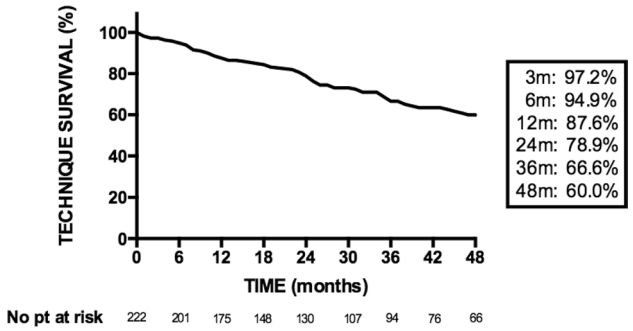

Fig. 1 Probability of technique survival in patients enrolled in urgent-start peritoneal dialysis program. *No* number; *pt* patients

of dialytic method during the first month after catheter placement.

The absolute number, management and rate of long-term mechanical complications are reported in Table 4. Neither late episodes of peri-catheter leakage nor late omental wrapping were observed. Nearly one third of the late complications (13/45; 35.2%) caused the discontinuation of PD, while one fourth (11/25; 24.4%) required surgical revision. The remaining episodes (21/45; 46.6%) were successfully managed by a conservative approach. Late episodes of hydroceles and hydrothorax determined PD drop-out in 56.2% of cases (Table 4).

The technique survival at 3, 6, 12, 24 36 and 48 months was 97.2, 94.9, 87.6, 78.9, 66.6 and 60.0%, respectively (Fig. 1). The causes of technique failure are shown in Fig. 2. The main causes of PD drop-out were represented by infectious episodes (36.8%) followed by mechanical complications (17.5%). Among the mechanical complications, hydrothorax and hydrocele caused 10% of the PD drop-outs while peri-catheter leakage and catheter displacement accounted for 3.2% of PD discontinuations.

Survival of the first catheter at 3, 6, 12, 24, 36 and 48 months was 93.6, 91.2, 84.8, 77.4, 65.5 and 59.3%, respectively (Fig. 3). The mean time of persistence of

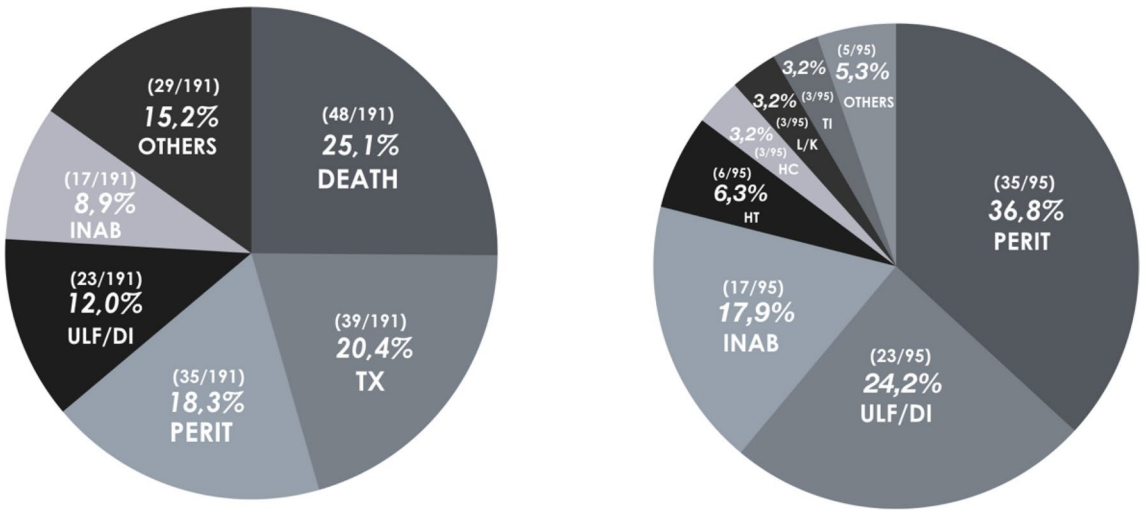

Fig. 2 Causes of technique failure with (left) and without (right) considering death non catheter-related and kidney transplantation. *TX* kidney transplantation; *PERIT* peritonitis; *ULF/DI* ultrafiltration failure/dialytic inadequacy; *INAB* loss of ability to perform peritoneal exchanges; *HT* hydrothorax; *HC* hydrocele; *L/D* leakage/displacement; *TI* tunnel infection

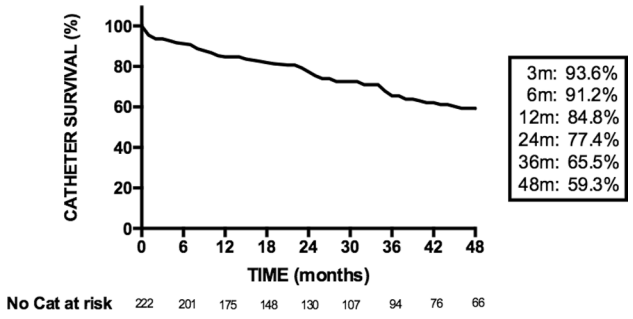

Fig. 3 Probability of first catheter survival. *No* number; *Cat* catheters

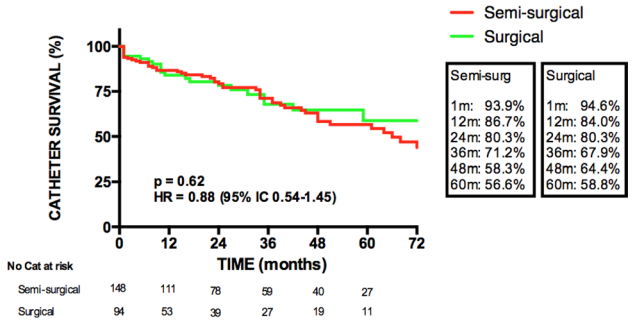

Fig. 4 Probability of catheter survival placed by semi-surgical procedure VS catheter survival inserted by surgical procedure. *No* number; *Cat* catheters; *HR* hazard ratio; *IC* interval of confidence

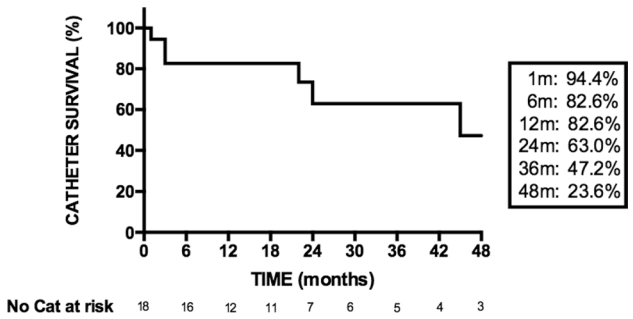

Fig. 5 Probability of second catheter survival. *No* number; *Cat* catheters

the first catheter was 34.5 ± 31.8 months. No significant difference in the first catheter survival among the semi-surgical and the surgical arm was observed (HR 0.88 [CI 0.54–1.45], $p = 0.62$ [Fig. 4]). Survival of the second catheter at 1, 6, 12, 24, 36 and 48 months was 94.4, 82.6, 82.6, 63.0, 47.2 and 23.6%, respectively (Fig. 5). The mean time of persistence of the second catheter was 32.7 ± 42.9 months. The causes of first and second catheter failure are shown in Fig. 6.

Discussion

Peritoneal dialysis is generally not considered a suitable renal replacement therapy in late referral patients or in the presence of acute kidney injury. The major concerns in using PD in a setting of dialytic urgency are represented by the complexity of placing a well-functioning PD catheter and the fear of early mechanical complications, such as dialysate leakage and catheter blockage/malpositioning [15, 24, 25].

Liu et al., in a retrospective study, divided 657 incident PD patients into those initiating peritoneal dialysis within 7 days, between 8 and 14 days, and more than 14 days from catheter placement [26]. The Authors observed that early mechanical complications were more common in subjects who initiated the peritoneal exchanges within 7 days as compared to 8–14 days and more than 14 days (8.4 vs. 3.6 vs. 1.7%, respectively). Similarly, in an Australian randomized controlled trial, 122 patients were randomized to start dialysis at 1, 2 or 4 weeks after open surgical PD catheter insertion [27]. They found that dialysate leakage in patients who initiated PD at 1 week from catheter insertion was significantly higher than in those starting at 2 or 4 weeks; therefore, the earlier the PD exchanges started, the higher the risk of mechanical complications.

We report the short- and long-term results of a UPD program in our study population; all patients started PD exchanges within 24 h of catheter implantation. The patients included in the study were unselected, most of them were elderly (mean age 62.4 ± SD 15.9 years) and had a high BMI (mean value 23.7, IR 21.1–26.4). We recorded a low incidence of short-term mechanical complications; in particular, the percentage of early leakage and catheter displacement was 4.5% and 2%, respectively. We speculate that this result could be due to the anti-leakage suture made around the deep cuff of the catheter, and to the specific initial dialytic scheme based on low-volume exchanges. In the literature, good results (less than 2% early leakage) were reported by Stegmayr et al. [28]. According to the Authors, the key factor of the success was a tight seal of the catheter to the surrounding tissues that was obtained using a particular insertion technique characterized by the "three purse strings" made at different sites (peritoneum, anterior and posterior rectus sheath). Similarly, low percentages of early leakage and displacement (less than 2%) after PD catheter placement were reported by two Chinese studies conducted on large populations [29, 30].

In our study the early incidence of omental wrapping in the short term did not exceed 2%. On the basis of our data, we believe that routine placement of the catheter by laparoscopic procedure carried out to minimize the risk of early mechanical catheter complications may not be worthwhile.

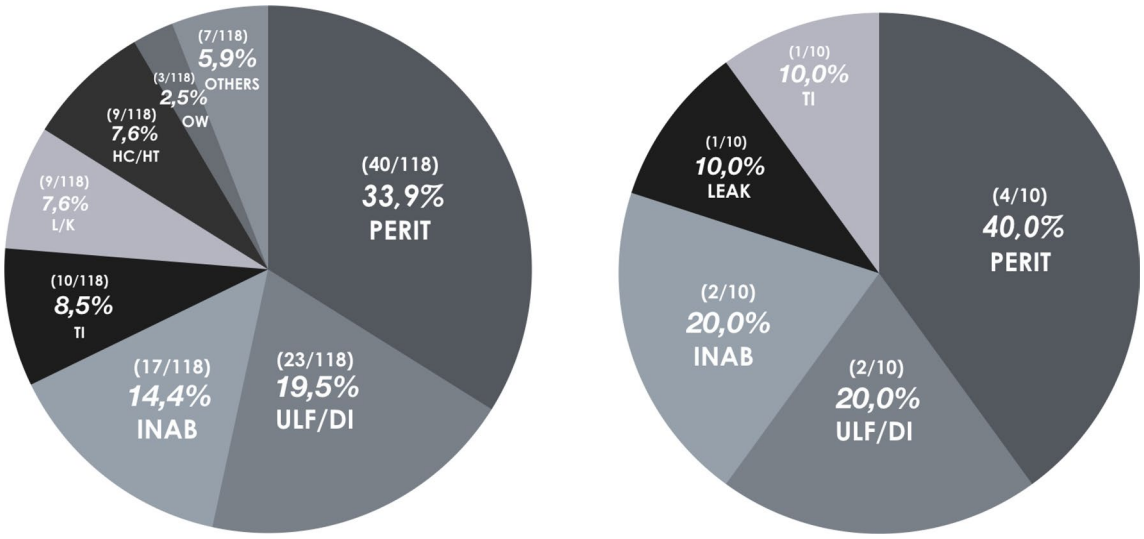

Fig. 6 Causes of first (left) and second (right) catheter loss. *PERIT* peritonitis; *ULF/DI* ultrafiltration failure/dialytic inadequacy; *INAB* loss of ability to perform peritoneal exchanges; *HT* hydrothorax; *HC* hydrocele; *TI* tunnel infection, *LEAK* leakage; *L/D* leakage/displacement; *OW* omental wrapping

Of the 23 cases of early mechanical complications, only one patient (4.3%) was transferred to HD, while thirteen out of twenty-three (56.5%) were successfully managed by a conservative approach, and nine out of twenty-three (39.1%) were rescued by surgical re/interventions. The low incidence of exit-site infections and peritonitis (1.6% and 2.5%, respectively) observed within 1 month from catheter insertion could be due to the accurate aseptic conditions that were adopted in the operating room and to the distance of the exit-site from the superficial cuff [31].

We were unable to demonstrate a difference in early mechanical complications or bleeding events between the semi-surgical and surgical groups; not one episode of intestinal perforation in the semi-surgical catheter placement was observed. Interestingly, once PD exchanges were resumed at home, none of the patients asked to change the dialytic method thus confirming the efficacy of the initial assessment as well as the excellent acceptance of the dialytic method itself.

The efficacy of our catheter insertion techniques was confirmed by long-term results. In particular, we observed a very low rate of peri-catheter leakage and displacement (0 and 0.019 number of episodes per patient-year, respectively) and excellent catheter survival. In fact, only one third of the late mechanical complications resulted in permanent discontinuation of the dialytic method, and peri-catheter leakage or dislocation accounted for just 3.2% of the overall PD drop-outs.

The observed discrepancy between technique and catheter survival during follow-up demonstrated that catheter failure did not always lead to the shift of the patients to HD, as confirmed by the excellent survival of the second catheters. These results show that prompt and appropriate surgical intervention could prevent the patient from permanently shifting to HD. In these cases, establishing a fecund collaboration with abdominal and thoracic surgeons becomes crucial to ensure the most opportune approach.

As expected, the main reasons for technique failure were represented by peritonitis and loss of ultrafiltration, which were responsible for about 37% and 25% of drop-outs, respectively.

In our series, almost 40% of catheter failures were due to infectious complications, such as peritonitis and tunnel infections, while mechanical complications accounted for 17.5% of cases.

Comparison of catheter survival according to the insertion technique (semi-surgical vs surgical) did not show a significant difference. Therefore, in selected patients the semi-surgical procedure represents a faster, less complex and more tolerable technique.

In conclusion, we believe that UPD can be safely used in patients who need dialysis urgently or in late-referral patients. However, to minimize mechanical complications it is mandatory to adopt a double purse-string technique [22] or any kind of strategy that allows a tight seal between the deep cuff and the surrounding tissues [28]. In patients without previous abdominal interventions, a semi-surgical catheter insertion procedure can be used by a skilled operator, and in fact, our data demonstrate that the semi-surgical technique is as effective as the surgical procedure in preventing early mechanical complications.

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Author contributions Research idea and study design: LN, AS; data acquisition: LN, EC; data analysis/interpretation: LN, AS; statistical analysis: LN; supervision or mentorship: GC. Each author contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved.

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Declarations

Conflict of interest We have read and understood Journal of Nephrology's policy on disclosing conflicts of interest and declare that we have none.

Ethical approval No required (retrospective cohort study undertaken through a case note review).

Informed consent to participate No required.

Informed consent to publish No doubt that anonymity can be maintained.

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