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Urgent-start peritoneal dialysis after laparoscopic dialysis catheter implantation: a single-center experience

Naohiro Toda[1,2*], Motoko Yanagita[1] and Hideki Yokoi[1]

Abstract

Background: Appropriate timing of peritoneal dialysis (PD) catheter implantation and PD initiation is important. Several guidelines suggest starting PD at least 2 weeks after PD catheter implantation. Recently, urgent-start PD is widespread throughout the world. However, the ideal time to start PD after laparoscopic catheter implantation is not known. We investigated the safety and feasibility of early initiation (within 7 days) PD following laparoscopic peritoneal catheter implantation.

Methods: We retrospectively analyzed patients who underwent laparoscopic PD catheter implantation at the Kyoto University Hospital from January 1, 2006, to December 31, 2016. Based on when PD was initiated, the patients were divided into two groups, namely, early group, ≤ 7 days and late group, > 7 days after catheter implantation. Catheter-related complications and catheter survival were analyzed.

Results: We analyzed 29 and 26 patients in early and late groups, respectively. The age, sex, the incidence of diabetes and APD, and the follow-up period were not significantly different between the two groups. The interval from catheter implantation to the start of PD was 4.28 ± 1.83 and 162 ± 157.8 days in the early and late groups, respectively ($P < 0.01$). In a late group, 17 patients (65.4%) underwent catheter implantation using the Moncrief–Popovich technique. The use of bridge hemodialysis was higher in the early group ($P < 0.01$). No patients developed dialysate leakage in both groups, and no significant differences were observed for catheter malfunction (24.1% vs. 19.2%, $P = 0.66$), exit-site infection (ESI, 24.1% vs. 28%, $P = 0.87$), and peritonitis (7.14% vs. 8.0%, $P = 0.91$) within 6 months. Furthermore, early initiation of PD did not increase the risk of ESI, peritonitis, and PD withdrawal at 1, 2, and 5 years compared to that in the late group.

Conclusions: Urgent-start of PD with laparoscopic catheter implantation did not increase infection-related complications and PD withdrawal. Laparoscopic PD catheter implantation may allow the initiation of PD earlier than 7 days after implantation.

Keywords: Peritoneal dialysis, Laparoscopic catheter implantation, Urgent-start, Leakage, Catheter survival, Exit site infection, Peritonitis

* Correspondence: natoda@kuhp.kyoto-u.ac.jp
[1]Department of Nephrology, Graduate School of Medicine, Kyoto University, 54 Shogoin Kawahara-cho, Sakyo-ku, Kyoto 606-8507, Japan
[2]Department of Nephrology, Kansai Electric Power Hospital, Osaka, Japan

Introduction

Peritoneal dialysis (PD) is an established method of home dialysis for patients with end-stage renal failure [1]. Currently, different catheter implantation techniques, such as open surgical placement, Moncrief–Popovich technique, peritoneoscopic placement, Seldinger technique, and laparoscopic placement, are in practice. The implantation technique may influence the occurrence of complications. In case of PD catheter implantation, the laparoscopic approach enables the surgeon to insert the catheter at the correct position under direct vision. Compared with those for open surgery, the meta-analysis of laparoscopic catheter implantation showed high 1-year catheter survival rates and less migration in the laparoscopic groups [2].

Proper timing of PD catheter implantation and PD initiation is important. Early initiation of PD after catheter implantation is generally avoided because of the increased risk of dialysate leakage and infection [3]. Thus, several guidelines include from the International Society of Peritoneal Dialysis (ISPD) suggest the initiation of PD at least 2 weeks after PD catheter implantation [4, 5]. In contrast, delaying PD initiation may increase the risk of bridge hemodialysis, which has an additional risk of complications, costs, and prolonged patient discomfort from uremia. To address this problem, several studies showed that starting PD within 14 days after catheter implantation is not associated with catheter-related complications [6–8]. Recently, initiation of PD earlier than 2 weeks after catheter implantation is called "urgent-start PD", and interest in the practice of urgent-start PD is spread internationally. In contrast, Ranganathan et al. conducted a randomized control trial (RCT) and showed that the risk of dialysate leakage was higher in groups that started PD 1 week after catheter implantation than in groups that started PD 2 weeks and 4 weeks after catheter implantation [9]. However, these results are due to open surgical implantation. The ideal time to start PD after laparoscopic catheter implantation is not known. Therefore, in this study, we aimed to investigate the safety and feasibility of early initiation (within 7 days) PD following laparoscopic peritoneal catheter implantation.

Methods

Participants

The retrospective study included all adult patients who started PD at the Kyoto University Hospital from January 1, 2006, to December 31, 2016. During this period, all patients who started PD at the Kyoto University Hospital underwent laparoscopic catheter implantation. Patients who could not be followed-up at least within 6 months after PD initiation and had catheter implantation at another hospital were excluded. We analyzed the patients to determine whether catheter loss due to catheter malfunction or exit-site infection (ESI) and peritonitis developed within 6 months. If the patient underwent more than one Tenckhoff catheter implantation during the observation period, only the first episode was considered for analysis. The patients were divided into the following two groups, based on when PD was initiated: those who started PD earlier than 7 days (early group) and later than 8 days (late group) after catheter implantation. Outcomes measured were the incidence of dialysate leakage, catheter malfunctions, ESI, and peritonitis within 6 months after PD initiation (all course, gram-positive coccus) and ESI-free patient survival, peritonitis-free survival, and catheter survival after PD initiation. The medical records of the patients were collected and analyzed until the time of death, transfer to hemodialysis, and transplantation or December 31, 2016, whichever came first. An experienced nephrologist reviewed the chart.

Laparoscopic catheter implantation

A double-cuffed swan neck PD catheter (JB-5A, Hayashidera, Kanazawa, Japan) was used for catheter placement in our hospital. All patients were under general anesthesia during the operation. The laparoscopic trocar was inserted in the opposite side periumbilical region exit-site. Carbon dioxide insufflation was performed to achieve pneumoperitoneum, and the laparoscopic camera was introduced via the port for general inspection of the abdominal and pelvic cavity. A vertical 5 cm incision was on the 2 cm lower than the navel and on the rectus muscle. The subcutaneous tissue and muscle layers were dissected to the posterior rectus sheath. The purse-suture of the peritoneum was performed under the vision of the laparoscopic camera. A 5-mm hole was created in the center of purse-suture, and Tenckhoff catheter with stylet was inserted in the peritoneal cavity. The tip of the catheter was placed in the pelvis under the vision of the laparoscopic camera. Catheter function was then tested by infusing 500 ml of 0.9% sodium chloride in peritoneal cavity and immediately draining. If the flow was good, purse-suture was placed on the internal cuff. The rectus muscle was closed. The catheter was tunneled in a smoothly curved fashion, and exit-site was made in the lower abdomen. The peritoneum and anterior rectus sheath of the camera port were closed. Finally, subcutaneous of all incisions were stitched.

In the case of the Moncrief-Popovich technique was used, the external segment of the catheter was buried in subcutaneous tissue at the time of catheter implantation.

In the time of PD initiation, the catheter was exteriorized by a small incision.

Peritoneal dialysis protocol

All patients were administered prophylactic intravenous antibiotics before PD catheter implantation. The dressing at the exit site was not changed for at least 1 week postoperatively. The exit site was examined for leakage daily from the time of initiation of PD to 1 week after initiation. After discharge, the exit site was examined for infection at 2-week intervals for the first 3 months. Daily catheter exit-site care included cleaning the exit site with 4% chlorhexidine after a shower.

Peritoneal dialysis was initiated at a low volume. On day 1, only 500–1000 ml dialysate per session was infused, and the dwell volume was gradually increased to 1500 ml. All exchanges were performed by a PD nurse or under their supervision until approximately 2 weeks. All participants did not use topical antibiotic creams at the exit site.

Definitions of outcomes

Leakage was defined as leakage of dialysate from the incision wound or exit site. If the fluid was present at the exit site, the glucose level of the fluid was checked. Dialysate leakage was defined when glucose level was higher in the fluid than in the blood. Catheter malfunction was defined as poor outflow and the need to undergo catheterography or alpha replacer technique [10]. Exit-site infection was defined as erythema, edema, tenderness, or drainage from the exit site. Cultures were obtained from the drainage, but a positive growth was not required. Peritonitis was defined as cloudy effluent with ≥ 100/μl white blood cells with ≥ 50% neutrophils.

Statistical analysis

Data were expressed as mean ± SD. Statistical analyses were performed using the Student t test with the JMP9 statistical software (SAS Institute, Cary, NC, USA). Time to infection was analyzed using the Kaplan–Meier survival analysis and log-rank test. P values < 0.05 were considered statistically significant.

Ethical consideration

This study was approved by the Ethics Committee on Human Research of the Graduate School of Medicine, Kyoto University, and was conducted in accordance with the guidelines of the Helsinki Declaration.

Results

Patient background

Of the 63 patients who started PD at the Kyoto University Hospital during the study period, 2 patients underwent catheter implantation at another hospital, 5 patients were transferred to other hospitals within 6 months of PD initiation, and 1 patient was transferred for renal transplantation. The remaining 55 patients were included for the analysis and divided into two groups based on when PD was initiated after catheter implantation. The early group comprised 29 patients who started PD ≤ 7 days after catheter implantation, and the late group comprised 26 patients who started PD ≥ 8 days after catheter implantation (Fig. 1). Table 1 shows the clinical features and laboratory findings when PD started. The mean age was 57.7 ± 14.9 and 57.2 ± 11.6 years in the early and late groups, respectively. The distribution of male participants was 48.3% and 50.0% in the early and late groups, respectively. The age, sex, the incidence of diabetes and APD, and the follow-up period were not significantly different between the two groups. The interval between catheter implantation to the start of PD was 4.28 ± 1.83 and 162 ± 157.8 days in the early and late groups, respectively (P < 0.01). In the late group, 17 patients (65.4%) underwent catheter implantation using the Moncrief–Popovich technique. In contrast, no patient in the early group underwent catheter implantation using the Moncrief–Popovich technique (P < 0.01). A significant difference was not observed in the use of catheter fixation technique. The use of bridge hemodialysis (HD) was higher in the early group, with 6 patients (20.7%), than in the late group, with 1 patient (3.85%, P < 0.01). The laboratory findings from when PD started showed no significant differences between the two groups for serum hemoglobin, albumin, blood urea nitrogen, sodium, potassium, phosphate, and C-reactive protein levels. The serum creatinine level of 8.05 ± 1.38 mg/dl in the early group was lower than that of 10.1 ± 3.74 mg/dl in the late group (P < 0.05). eGFR level of 5.41 ± 0.98 ml/min/1.73 m^2 in the early group was higher than that of 4.58 ± 1.06 mg/dl in the late group (P < 0.01). Serum calcium level of 8.12 ± 0.94 mg/dl in the early group was lower than that of 8.78 ± 0.95 mg/dl in the late group (P < 0.05).

Catheter-related complications within 6 months

Table 2 shows catheter-related complications within 6 months. None of the patients in either groups developed dialysate leakage. Catheter malfunction occurred in 7 patients (24.1%, 2 patients; dislocation, 1 patient; omentum folding, 1 patient; fibrin, 3 patients; unknown) and 5 patients (19.2%, 2 patients; dislocation, 1 patient; omentum folding, 1 patient; fallopian tube wrapping, 1 patient; unknown) in the early and late groups, respectively. Of these, 2 patients in the early group developed catheter loss by greater omentum folding or dislocation. Exit-site infection developed in 8 (27.6%) and 7 patients (26.9%) in the early and late

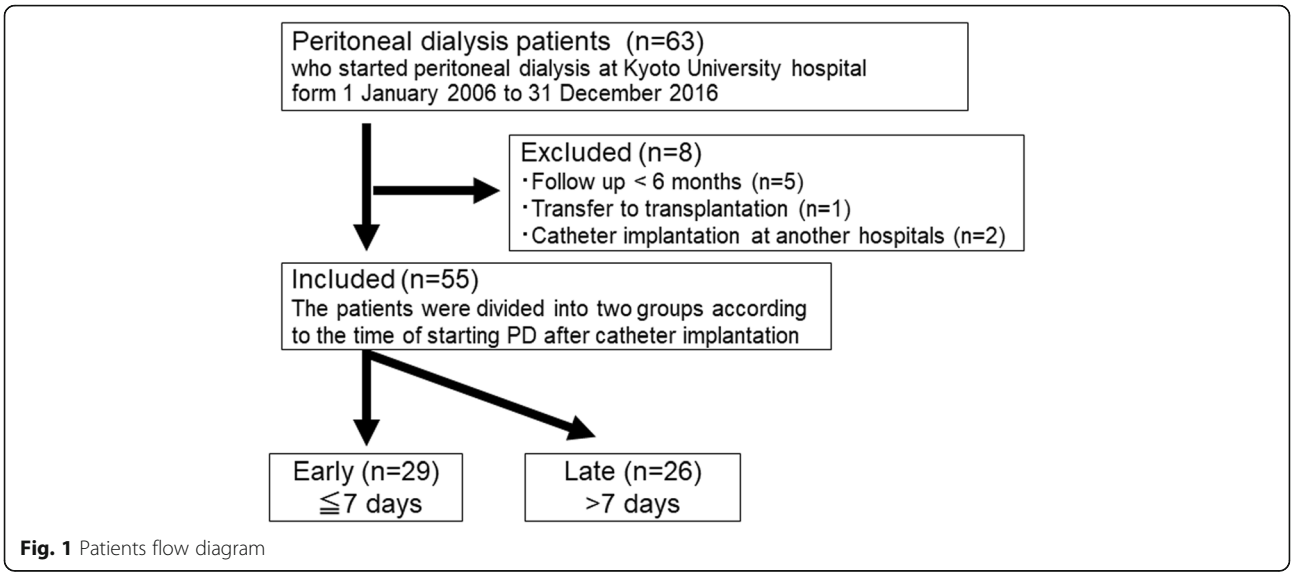

Fig. 1 Patients flow diagram

groups, respectively. Peritonitis developed in 2 patients each in the early (6.9%) and late (7.7%) groups. Significant differences were not observed in the incidence of catheter malfunction (P = 0.66), ESI (P = 0.96), and peritonitis (P = 0.91) between the two groups. None of the patients developed catheter loss due to ESI or peritonitis in both groups within 6 months.

Infective organism in ESI and peritonitis within 6 months

Six patients developed ESI in the early group due to gram-positive cocci (MSSA, 6 patients), while 2 patients who developed ESI were culture negative. In contrast, only 3 of the 7 patients in the late group developed ESI due to gram-positive cocci. Two patients developed ESI due to gram-negative rodent, and 2 patients were culture-negative in the late group. No significant differences were found between the two groups with respect to ESI and peritonitis due to gram-positive cocci. Two patients in the early group experienced 2 episodes of *Streptococcus*-induced peritonitis, and 2 patients in the late group experienced 2 episodes of culture-negative peritonitis. None of the patients experienced ESI together with peritonitis due to the same organism in both groups within 6 months.

Table 1 Clinical characteristic of the patients (n = 55)

	Total (n = 55)	Early (n = 29)	Late (n = 26)	P value
Age	57.5 ± 13.3	57.7 ± 14.9	57.2 ± 11.6	0.593
Sex (male)	27 (49.1%)	14 (48.3%)	13 (50.0%)	0.593
Diabetes	8(14.5%)	5 (17.2%)	3 (11.5%)	0.708
Duration between the start of PD and catheter implantation (days)	78.6 ± 18.0	4.28 ± 1.83	162 ± 157.8	< 0.01
Moncrief-Popovich technique	17 (31.0%)	0 (0.00%)	17 (65.4%)	< 0.01
Catheter fixation	15 (27.2%)	8 (27.6%)	7 (26.9%)	1.00
Bridge hemodialysis	7 (12.7%)	6 (20.7%)	1 (3.85%)	< 0.05
Hemoglobin (g/dl)	9.72 ± 1.53	9.73 ± 0.29	9.72 ± 0.30	0.99
Albumin (g/dl)	3.76 ± 0.54	3.72 ± 0.53	3.80 ± 0.56	0.57
BUN (mg/dl)	87.0 ± 3.30	85.5 ± 6.29	88.7 ± 6.53	0.73
Creatinine (mg/dl)	9.06 ± 2.95	8.05 ± 1.38	10.1 ± 3.74	< 0.05
eGFR (ml/min/1.73 m^2)	5.01 ± 1.10	5.41 ± 0.98	4.58 ± 1.06	< 0.01
Sodium (mEq/L)	139.2 ± 2.85	138.8 ± 2.53	139.8 ± 3.13	0.19
Potassium (mEq/L)	4.85 ± 0.76	4.91 ± 1.72	4.78 ± 2.00	0.51
Calcium (mg/dl)	8.45 ± 1.00	8.12 ± 0.94	8.78 ± 0.95	< 0.05
Phosphorus (mg/dl)	6.19 ± 1.85	6.01 ± 1.72	6.38 ± 2.00	0.47

Table 2 Catheter-related complications within 6 months

	Early (n = 29)	Late (n = 26)	P value
Leakage	0	0	
Catheter malfunction	7 (24.1%)	5 (19.2%)	0.66
Exit site infection	8 (27.6%)	7 (26.9%)	0.96
Peritonitis	2 (6.9%)	2 (7.7%)	0.91

Long-term outcomes of ESI, peritonitis, and catheter survival

The follow-up period was 47.9 ± 5.22 months and 58.3 ± 6.53 months in the early and late groups, respectively. The ESI-free survival rates at 1, 2, and 5 years were 66.5%, 35.8%, and 30.7%, and 65.0%, 56.0%, and 44.5% in the early and late groups, respectively (Fig. 2a). The incidence of ESI tended to be higher in the early group, but it was not significant (log-rank P = 0.38). The peritonitis-free survival rates at 1, 2, and 5 years were 92.4%, 79.6%, and 61.3%, and 92.3%, 83.5%, and 68.4% in the early and late groups, respectively (Fig. 2b). The catheter survival rates at 1, 2, and 5 years were 92.9%, 88.6%, and 73.2%, and 96.0%, 87.7%, and 83.0% in early and late groups, respectively (Fig. 2c). No significant difference in the incidence of peritonitis (P = 0.95) and catheter survival (P = 0.78) between groups.

Discussion

This observational study suggested that early initiation of PD after laparoscopic dialysis catheter implantation does not increase the risk of catheter-related complications. This study is the first to evaluate the clinical outcomes of PD patients, depending on the timing of PD initiation after laparoscopic catheter implantation.

Urgent-start dialysis is commonly performed by hemodialysis using a temporary central venous catheter. However, the use of a central venous catheter led to

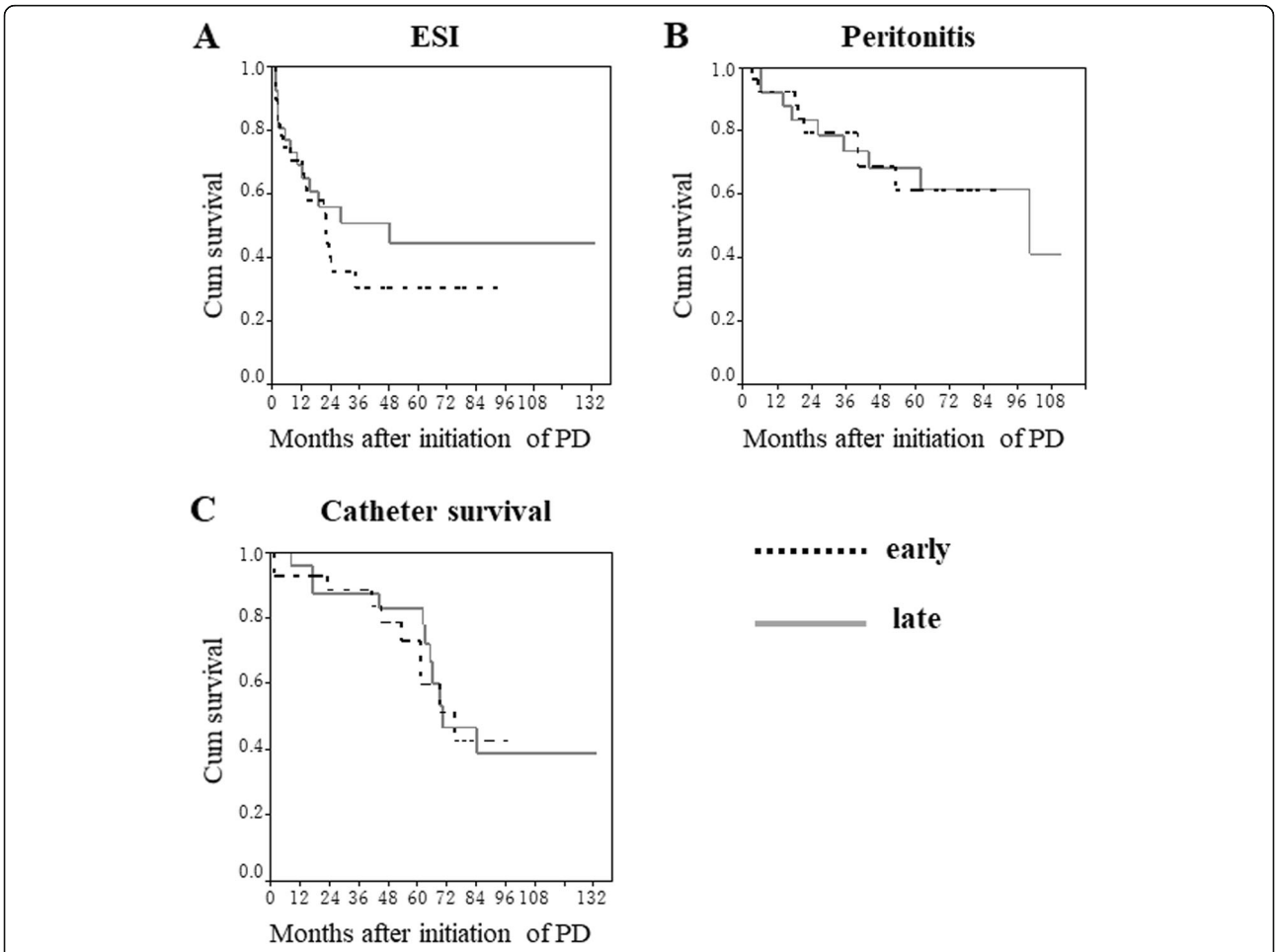

Fig. 2 **a** Kaplan-Meier curve for ESI-free survival according to the timing of initiation of peritoneal dialysis: early start versus late start. No significant difference between groups (log-rank P = 0.38). **b** Kaplan-Meier curve for peritonitis-free survival according to the timing of initiation of peritoneal dialysis: early start versus late start. No significant difference between groups (log-rank P = 0.95). **c** Kaplan-Meier curve for catheter survival according to the timing of initiation of peritoneal dialysis: early start versus late start. No significant difference between groups (log-rank P = 0.78). Early = break-in period < 7 days, Late = break-in period ≥ 7 days

increased incidence of infection and mortality [11, 12]. Jin et al. reported urgent-start PD was associated with fewer short-term dialysis-related complications and survival rates similar to those observed for urgent-start HD [13]. Thus, interest in the practice of urgent-start PD is increasing, and several studies have reported the safety and efficacy of urgent-start PD [14]. Although many reports defined urgent-start as who started PD earlier than 2 weeks, we defined early group who started PD earlier than 7 days. The short break-in period after catheter implantation can reduce the duration of hospitalization.

The timing of PD initiation from catheter implantation is one of the important problems in PD treatment. The ISPD guideline suggested that catheter implantation should be performed at least 2 weeks before PD initiation. A shorter duration may not allow for adequate healing of the surgical wound, which leads to increased risk of dialysate leakage, resulting in an increased incidence of ESI and peritonitis [6]. In an observational study, which reported PD initiated within 1 week after catheter implantation by open surgery, only 3 out of 922 patients developed dialysate leakage [15]. Once dialysis leakage occurs, it leads to increased risk of catheter-related infections. Holley et al. showed 42% concurrence of dialysate leakage and infection [16]. In this study, no episodes of dialysate leakage occurred in both groups. This low incidence of dialysate leakage in this study may lead to no significant difference in incidences of ESI, peritonitis, and catheter survival.

Ranganathan et al. showed that the risk of dialysate leakage in groups that started PD 1 week after catheter implantation (28.4%) was higher than in groups that started PD 2 weeks after catheter implantation (2.8%) in a timely PD study. However, catheter infection and technique failure were not significantly different in both groups [9]. Another report also showed that although leakage increased in urgent-start PD, no significant difference in infectious complications and technique survival was observed compared with conventional-start PD [14]. In this study, the start volume of dialysate was 500 ml and the volume was gradually increased to 1500 ml. On the other hand, Song et al. showed that immediate full volume dialysate exchange did not cause leakage and catheter loss after percutaneous insertion [17]. These results of catheter-related infection and of technique failure are consistent with our results. The difference between the results pertaining to leakage in this study and those in previous studies by open surgery may be due to laparoscopic catheter implantation.

Laparoscopic catheter implantation needs more incisions and operation time, but it has the advantage of direct visual placement of the catheter and adhesiolysis. Recently, an RCT comparing open versus laparoscopic catheter implantation was published. In this RCT study, PD was started 2 to 4 weeks after catheter implantation. This study revealed that dialysate leakage only occurred in 1 out of 46 patients in the laparoscopic group and in none of the 44 patients in the open surgery group. No statistically significant difference was observed in the incidence of ESI and peritonitis [18]. Compared with open surgery, the meta-analysis of laparoscopic catheter implantation showed no statistically significant difference in the incidence of leakage. In addition, the odds ratio of peritonitis and ESI in laparoscopic implantation was smaller but not significant compared to that in open surgery [2, 19]. The time to start PD after catheter implantation in meta-analysis was varied. Therefore, it is difficult to draw a definite conclusion for the leakage. Tsimoyiannis et al. conducted an RCT to investigate the results of laparoscopic versus open surgery. Peritoneal dialysis was started 24 to 48 h later. Fluid leakage was observed in 8 patients in the open surgery group, but in none of the patients in the laparoscopic group [20]. This result indicates that laparoscopic catheter implantation allows early start of dialysis without fluid leakage.

In this study, the serum calcium level was lower and the use of bridge HD was higher in the early group than in the late group. Hypocalcemia during the pre-dialysis period has been reported as a risk factor of PD technique failure [21]. In addition, the increased use of bridge HD in the early group suggests that many of these patients were unplanned dialysis start or late referral and the general condition of patients was poor compared with that of the patients in the late group. Despite these patient conditions in the early group, no significant difference was observed in the incidence of ESI, peritonitis, and catheter survival. These data support our findings of the safety of early peritoneal dialysis initiation within 7 days after laparoscopic catheter implantation.

This study has several limitations. The sample size was small, and it was an observational study. These limitations could be addressed with RCTs. Further RCTs are needed to confirm our observation. The strengths of this study are that it is the first study to evaluate the clinical outcomes of PD patients, depending on the timing of PD initiation after laparoscopic catheter implantation. In addition, our results that early PD initiation did not increase catheter-related infections were consistent with those reported in previous open surgery studies.

Conclusions

In conclusion, the patients who started PD early after laparoscopic catheter implantation did not have an increased risk of ESI, peritonitis, and technique failure. Laparoscopic PD catheter implantation may allow the initiation of PD earlier than 7 days after implantation.

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Authors' contributions
NT and HY wrote the paper. MM revised it. All authors read and approved the final manuscript.

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Availability of data and materials
The datasets used and analyzed during the current study available from the corresponding author on reasonable request.

Ethics approval and consent to participate
This study was approved by the Ethics Committee on Human Research of Graduate School of Medicine, Kyoto University, and was conducted in accordance with the Helsinki Declaration.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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