Early Postoperative Complications of Peritoneal Dialysis Catheter Surgery Conducted by Nephrologists: A Single-Center Experience Over an Eight-Year Period

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The results of several recent studies indicate that the practice of peritoneal dialysis catheter (PDC) insertion by nephrologists is safe. However, few studies have addressed the important issue of safety in surgeries related to PD, including PDC removal and other types of surgery. In the present study, we aimed to verify whether the incidence of early postoperative complications for surgical procedures related to PD and performed by nephrologists meets the audit standards of clinical practice guidelines for peritoneal access.

*Between April 2008 and July 2016 at our hospital, 282 patients underwent various types of PD-related surgery conducted by 17 nephrologists. The surgery types were the Moncrief–Popovich technique (*n = *74), PDC exteriorization (*n = *62), conventional laparotomy insertion (*n = *29), PDC removal (*n = *70), partial replacement (*n = *32), unroofing or cuff shaving (*n = *7), and others (*n = *8).*

Bowel perforation and significant hemorrhage did not occur at the time of PDC insertion and removal. Although peritonitis was not evident, exit-site and tunnel infection within 2 weeks of PDC insertion by conventional laparotomy or exteriorization after the Moncrief–Popovich technique occurred in 3 of 91 patients (3.3%). The PDC malfunctioned in 2 of 103 patients (1.9%) after the Moncrief–Popovich technique because of PDC occlusion with a fibrin plug. Dialysate leaks occurred in 2 of 103 patients (1.9%). Partial replacement and unroofing or cuff shaving for refractory PDC infection and other type of surgeries were not associated with serious complications.

The incidence of complications after surgery related to PD was low at our institution. The incidences of complications met the audit standards in the guidelines, indicating that surgery by nephrologists is safe and effective.

Key words
Laparotomy, postoperative complications, safety, clinical practice guidelines

Introduction

One key to successful peritoneal dialysis (PD) is correct positioning of a PD catheter (PDC) in the peritoneum without complications. In the United States, surgeons insert most PDCs; nephrologists insert only 2.3% (1). In contrast, surgeons and nephrologists have both traditionally inserted PDCs in Japan. Interventional nephrologists in various countries have recently begun to insert PDCs, and the reported outcomes are comparable to those for insertions performed by surgeons (2,3). However, little is known about complications associated with PDC surgeries conducted by nephrologists.

Postoperative complications of PDC insertions are classified as early (surgical wound hemorrhage or catheter exit-site hemorrhage, bleeding, intestinal or urinary-bladder perforation, dialysate leakage) or late (problems with the outflow or inflow of dialysate, hernias, hydrothorax, encapsulating peritoneal sclerosis) (4). Late complications are difficult to predict at the time of surgery, but early complications might be significantly affected by surgical skill. Clinical practice guidelines for peritoneal access provide audit standards for catheter-related complications—specifically, bowel

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perforation, less than 1%; significant hemorrhage, less than 1%; exit-site infection (ESI) within 2 weeks of PDC insertion, less than 5%; peritonitis within 2 weeks of PDC insertion, less than 5%; functional catheter problems requiring manipulation or replacement or leading to technique failure, less than 20% (5).

In the present study, we aimed to verify whether the incidence of early postoperative complications after PDC surgery conducted by nephrologists meets the audit standards in the clinical practice guidelines for peritoneal access.

Methods

Between April 2008 and July 2016, 282 surgeries related to PD (Moncrief–Popovich technique, $n = 74$; PDC exteriorization, $n = 62$; conventional laparotomy insertion, $n = 29$; PDC removal, $n = 70$; partial replacement, $n = 32$; unroofing or cuff shaving, $n = 7$; and others, $n = 8$) were performed on 141 patients (79 men; mean age at the time of surgery: 61 ± 14 years; 49 with diabetic nephropathy). The 17 nephrologists who conducted the procedures at St. Marianna Medical School Hospital had various lengths of experience (range: 1 – 13 years).

We defined early postoperative complications as all those that developed within 2 weeks after surgery. The study was approved by the institutional review board of the St. Marianna University School of Medicine.

Insertion of PDCs

Triple-cuffed straight or double-cuffed swan-neck PDCs were used. The Moncrief–Popovich technique or conventional laparotomy insertion proceeded under spinal or general anesthesia. Exteriorization at the start of PD proceeded under local anesthesia. The average time from the Moncrief–Popovich technique to exteriorization was 3.7 months.

All surgeries related to PD proceeded in an operating room under sterile conditions. Intravenous cefazolin (1 g) was given as antibiotic prophylaxis before all surgical procedures. The bladders of all patients were emptied by indwelling urinary catheter before PDC insertion. The Moncrief–Popovich technique proceeded as described by Brum *et al.* (6). The PDCs were inserted through paramedian incisions, which, compared with median incisions, are associated with fewer complications (7).

After conventional laparotomy insertion or exteriorization of a PDC, the exit site was covered with a sterile occlusive dressing that remained in place for 7 – 10 days. Postoperative exit-site care started at 2 weeks after surgery. The patients introduced to PD by the Moncrief–Popovich technique started with 1.5 – 2.0 L dialysis solution. Patients introduced to PD by conventional laparotomy insertion gradually increased their dwell volume from 500 mL to 2.0 L.

PDC removal

Open surgical technique under spinal or general anesthesia was used for PDC removal. The removal of a PDC was performed either for an acute situation such as peritonitis, or as a planned procedure after a modality switch to hemodialysis. Subcutaneous tissues were debrided in patients with ESI or tunnel infection.

Partial replacement and unroofing or cuff shaving

To treat refractory ESI, tunnel infection, and outer cuff extrusion, partial PDC replacement with unroofing or cuff shaving was performed under local or spinal anesthesia (8). The most recent preference in such circumstances is partial replacement, in which a new exit site is positioned far from the infected section without removing the deep cuff. This procedure is associated with a short hospitalization, and PDC removal or PD interruption is not required.

Other types of surgery

In elderly patients at high risk for PDC removal, the catheter has been re-embedded on discontinuation of PD (9).

Results

No patient failed to have a PDC inserted because of adhesions from previous abdominal surgeries. Bowel perforation, significant hemorrhage, and peritonitis after surgery did not occur during any PDC insertion or removal. No other perioperative complications (hemoperitoneum, kinking) were observed after surgery.

In 3 of 91 patients (3.3%), ESI developed within 2 weeks of PDC insertion by conventional laparotomy ($n = 1$) or externalization after the Moncrief–Popovich technique ($n = 2$). The causative bacteria were *Staphylococcus aureus,* coagulase-negative staphylococci, and *Corynebacterium* species. The treatments for ESI and tunnel infection followed the International Society for Peritoneal Dialysis guideline protocol (10,11), using intraperitoneal or oral antibiotics. No patient required PDC removal.

Functional catheter problems (PDC occlusion by fibrin plug after Moncrief–Popovich technique) requiring manipulation or replacement, or causing technique failure, occurred in 2 of 103 patients (1.9%). As a treatment for occlusion, the tip of the catheter was exposed by laparotomy under spinal anesthesia, and the fibrin plug was removed. Both affected patients were able to start PD without any problems.

Dialysate leaks occurred in 2 of 103 patients (1.9%). Mechanical damage was the cause in one case, and a leak developed in the other case at the time of exteriorization of a PDC inserted using the Moncrief–Popovich technique. Unfortunately, one of those patients chose PDC removal because he hoped to transition from PD to hemodialysis. In another patient, PD was temporarily held for a month and then restarted with a lower volume. That patient was able to continue PD without a recurrence.

In addition, partial replacement and unroofing or cuff shaving for refractory ESI or tunnel infection and all other types of surgery were not associated with early postoperative complications.

Discussion

The reported incidence of procedure-related perforation during PDC insertion is 0.7% – 2.6% (12). Although a procedure-related perforation is an extremely rare complication, it is serious, and emergency surgery is necessary if it develops after PDC insertion. We did not experience a single instance of perforation in a total of 103 PDC insertions.

Significant hemorrhage after PDC insertion is also rare. Mital *et al.* (13) reported that the incidence of major bleeding complications associated with PDC insertion is about 2% (6 of 292 patients). Because bleeding is reportedly affected by anticoagulation, we did not resume anticoagulation therapy for 24 hours after surgery, and bleeding complications were not excessive in our patients. Moreover, when providing a long subcutaneous tunnel, we abandoned the technique of using a sharp needle to create the exit site, and thus bleeding from exit sites did not continue in our patients.

Korzets *et al.* (14) reported that some complications (bleeding, local infection, retained cuff, peritoneal fistula, and pseudo-aneurysm in the inferior epigastric artery) occur with PDC removal. However, Kahveci *et al.* (15) reported that the incidence of complications related to PDC removal is extremely small, and we also did not experience any complications after PDC removal. Restrepo *et al.* (16) reported the incidences of ESI and tunnel infection to postoperative day 30 in patients whose PDCs were inserted by nephrologists. In that study, the incidence of ESI was 3.82% (6 of 157 patients), and the incidence of tunnel infection was 0%. Restrepo *et al.* also found a 6.37% incidence of peritonitis up to postoperative day 30. Chow *et al.* (17) reported a 4.4% incidence of ESI (11 of 250 patients) within 1 month of PDC insertion, and a 3.6% incidence of peritonitis (9 of 250 patients). Our findings for ESI and tunnel infection were equivalent to those in the foregoing studies. We believe that the incidence of ESI was low because the Moncrief–Popovich technique was successful in our patients. Peritonitis did not arise at all in the present study.

Several reports have described catheter malfunction such as migration, obstruction, kinking, and wrapping after surgery performed by nephrologists. Omental occlusion of a PDC is a relatively frequent complication. Indeed, the PDC became plugged with fibrin in 2 of our patients, both of whom had received implanted catheters more than 1 year earlier by the Moncrief–Popovich technique. Brown *et al.* (18) reported that the risk of a fibrin plug increases with the amount of time that a catheter is not in use. A long burial period might have affected the PDC occlusion in our patients.

The reported incidence of dialysate leakage is 5% – 20% (19). Kubota *et al.* (20) reported that no patients treated using the Moncrief–Popovich technique experienced dialysate leakage. We therefore adopted the Moncrief–Popovich technique for about 72% of PDC insertions. Mechanical damage of the PDC at the time of exteriorization was responsible for a dialysate leak in one of our patients, and a PDC inserted by the Moncrief–Popovich technique leaked in another patient. Although we set a burial period of 1 month, dialysate leaks occurred after externalization. We believed that the cause of the dialysate leak in the second case was steroids taken by a patient with systemic lupus erythematosus who experienced delayed wound healing.

Table I shows prior reports of complications accompanying PDC insertion by nephrologists.

Of the various methods of PDC insertion, such as conventional laparotomy, laparoscopy, fluoroscopic guidance, and percutaneous insertion using the Seldinger technique, nephrologists have usually chosen to perform percutaneous insertion (24,25). The percutaneous

TABLE I Postoperative complication rates for peritoneal dialysis catheter surgeries conducted by nephrologists

Reference	*Pts (n)*	*Follow-up*	*Bowel perforation (%)*	*Hemorrhage (%)*	*Exit-site infection (%)*	*Peritonitis (%)*	*Functional problem with catheter (%)*	*Dialysate leak (%)*
Chow *et al.,* 2010 (17)	250	1 Month	0.8	Not reported	4.4	3.6	Omental wrap or entrapment: 1.6 Catheter blockade with intraluminal blood clots: 0.4	0.4
Yang *et al.,* 2011 (21)	310	6 Months	Not reported	0.3	1.0	3.6	Diminished outflow volume: 3.9 Migration: 2.9 Pericatheter hernia: 0.3	2.6
Restrepo *et al.,* 2014 (16)	157	1 Month	1.9	1.3	3.8	6.4	Kinking: 3.2 Drainage failure: 4.5 Omentum or bands trapping: 1.3	1.9
Washida *et al.,* 2015 (22)	120	2528 Pt–months	0.8	0.8	Not reported	0.8	Obstruction: 2.5 Migration: 15 Omental wrapping: 0.8 Fallopian tube wrapping: 1.7	0.8
Ros-Ruiz *et al.,* 2016 (23)	172	1 Month	0	1.7	Not reported	0.6	Exit-site hernia: 0.6 Omental entrapment: 0.6	0
Present report	282	2 Weeks	0	0	3.3	0	Catheter occlusion by fibrin plug: 1.9	1.9

Pt(s) = patient(s).

method has some advantages, including low cost, avoidance of general anesthesia, less postoperative pain, and a shorter procedure time. However, the procedure is blind, which, compared with laparotomy, confers a higher risk of intestinal perforation and massive bleeding. Although laparotomy is invasive, it reduces the risk of serious complications. Nephrologists in various countries have recently performed laparotomy insertions with good outcomes (16,17,21–23).

Washida *et al.* (22) reported that PDC insertion by nephrologists also has favorable effects on tripartite communications between patients, nurses, and nephrologists. To improve surgical skills, we conduct training for PD surgery using a simulator (26), and we believe that such training might have contributed to our low incidence of surgical complications.

Our study has several limitations. The first one is its retrospective observational nature. Second, the number of patients was small and the observation period was short compared with the same factors in other studies. We plan to further investigate the long-term safety of PDC surgeries conducted by nephrologists.

Conclusions

The incidence of early postoperative complications after PD-related surgery by nephrologists at our institution was well below reported values and within the evaluation criteria for PDC insertion published in clinical practice guidelines. Our findings indicate that PDC-related surgery conducted by nephrologists is effective and safe. However, to avoid adverse events arising during surgery, we emphasize that cooperation with surgeons is essential for insertions in high-risk patients and in patients with pre-existing complications.

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Disclosures

We understand that *Advances in Peritoneal Dialysis* requires disclosure of any conflicts of interest, and we declare that we have no conflicts to disclose.

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