A CHANGE TO RADIOLOGICAL PERITONEAL DIALYSIS CATHETER INSERTION: THREE-MONTH OUTCOMES

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Background: Best practices for peritoneal dialysis (PD) catheter insertion call for timely placement of catheters to reduce complications and increase the likelihood of a successful initiation of PD. The purpose of our study was to assess if a change in approach to PD catheter insertion, including a switch to radiological insertion of PD catheters and introduction of a dialysis access nurse to coordinate all patient care, was associated with more outpatient procedures and achievement of guideline-based outcomes, including timelier PD starts.

Methods: We conducted a single-center retrospective chart review of all patients that had their first PD catheter inserted at our center over a 7-year period ending in 2007. The new procedure of radiological insertion and in 125 patients by surgical insertion during an earlier period. Insertion of PD catheters by interventional radiology was significantly associated with a higher rate of outpatient procedures (70% vs 32%, p < 0.0001) than surgical placement. At PD start, 82% of patients that underwent radiological insertions had an estimated glomerular filtration rate of over 8 mL/minute/1.73 m² and their mean serum albumin level was 38.2 g/L.

Conclusions: The new procedure of radiological insertion of PD catheters, coordinated by a dedicated dialysis access nurse, was associated with more outpatient procedures than the earlier surgical method and allowed patients to receive a PD catheter with timing consistent with clinical practice recommendations.

Peritoneal dialysis (PD) provides a stable and safe means of renal replacement therapy. Survival rates on PD are similar to or better than those on hemodialysis during the first year after starting therapy (1–3). However, the PD catheter itself can be the Achilles’ heel of the procedure. For patients initiating PD, early PD catheter failure often leads to transfer to hemodialysis, either temporarily or permanently (4). In a recent review of best practices for PD catheter insertion and exit-site care, catheter-related problems were reported as a cause for up to 20% of patients switching from PD to permanent hemodialysis (5). To retain patients on a home PD program and increase the total number of PD patients, special attention is required to ensure that PD catheter insertion procedures are safe and that complications are minimized. While the catheter type and insertion method are important, the experience of the access team (including both physicians and nurses) is of equal or greater importance (6).

Different methods of catheter placement techniques have been developed since Tenckhoff first introduced the modern soft Silastic PD catheter in 1968 (7). The following are the main techniques: surgical (8), laparoscopic (9), and “blind” with a trocar (10) or with a Seldinger technique (11). A recent international survey of PD centers found that the surgical method is still the most common technique (36 of 50 centers) (12). The surgical method, in which catheter insertion requires surgeons, anesthesia, and operating room time, may lead to delays in catheter insertion and PD start, depending on the resources of the medical center. Percutaneous techniques allow for PD catheter insertion by either interventional radiologists under fluoroscopy or by nephrologists in an interventional access suite. This can permit flexible booking of appointments for catheter insertion and eliminate competition for operating room time (13–15).

Recent publications on best practices for peritoneal access have all tried to optimize care for patients and decrease complications (5,6,16,17). Best practices for PD catheter insertions include timely placement of catheters...
to allow healing of the exit site prior to initiating PD and initiating PD before the glomerular filtration rate (GFR) falls below 8 – 10 mL/minute/1.73 m² (5,6,18). The rationale for allowing healing of the PD catheter exit site before starting PD is minimization of the incidence of leaks and infections at the exit site. A minimum of 2 weeks is usually recommended (6,16); however, there are successful reports of immediate PD start after percutaneous insertion (19). The rationale for promoting the initiation of PD when the GFR is 8 – 10 mL/minute/1.73 m² is prevention of a belated PD start. When the GFR falls below 8 – 10 mL/minute/1.73 m², the risk of a patient developing malnutrition is increased due to increased symptoms of uremia, subsequently leading to poor outcomes (18).

The purpose of this retrospective study was to assess if a change in approach to PD catheter insertion, including a switch to radiological insertion of PD catheters and introduction of a dialysis access nurse to coordinate all patient care, was associated with more outpatient procedures and achievement of guideline-based outcomes, including timelier PD starts.

SUBJECTS AND METHODS

The home dialysis program at our center has been active since 1975; approximately 30% of the total number of patients on dialysis are on home PD. In the year 2000, at the start of this study, 70 patients were on PD and 142 were on hemodialysis; by 2007, 75 were on PD and 179 were on hemodialysis. A dialysis access nurse has coordinated the access care for patients requiring PD since July 2003, when the radiological insertion method first became available. Prior to that date, all PD catheter insertions were performed surgically. A move to radiological PD catheter insertion occurred when a new interventional radiologist trained in this technique joined our center and could provide radiological PD catheter insertions as easily as radiological insertions of tunneled hemodialysis catheters. The interventional radiologists have used only double cuff, swan neck, curled tip, PD catheters provided by Medionics International (Markham, ON, Canada).

Radiological PD catheter insertions at our center are performed under local anesthesia and conscious sedation, using both sonographic and fluoroscopic guidance. In brief, a 5-cm incision is made 2 – 4 cm lateral to the umbilicus. The approach is a modified Seldinger technique whereby a 22-gauge needle is advanced into the peritoneal space under ultrasound guidance and its intraperitoneal location confirmed with a small amount of contrast material injected under fluoroscopy. A micro-puncture system is used to upsize the access and insert the necessary guidewire (0.035" guide wire) to provide a clear path toward the pelvis. A peel-away introducer sheath is then placed over the wire. Finally, the PD catheter, mounted on a stylet, is placed deep in the pelvic cavity under fluoroscopic guidance. Once the catheter is in place, the peel-away sheath is removed. The deep cuff is then sutured to the rectus fascia. An inferolaterally angled subcutaneous tunnel is created using a Faller stylet, being sure to create an exit site that avoids the belt line. Previous abdominal surgery was not a contraindication but each patient with previous surgery was first evaluated by the radiologist.

Just prior to initiation of the radiological insertion of PD catheters, a dialysis access nurse began coordinating new PD catheter insertions and has standardized the procedures and teaching for patients for this procedure.

All patients that had their first PD catheter inserted at our center between 1 January 2000 and 30 May 2007 were identified from the hospital’s health data department, the nephrology electronic record, and the local dialysis registry. Data collected for this study included the location of the PD catheter insertion (operating room or radiology), the insertion and training as either an inpatient or an outpatient, laboratory data at PD start, whether the patient was still on PD 3 months after PD start, and complications during the first 3 months. Patients were excluded if they transferred to another PD center within 3 months of PD start. Approval for the study and documented data abstraction from charts without the requirement for individual patient consent was obtained from the Research Ethics Board at Sunnybrook Health Sciences Centre, Toronto, Canada.

The primary outcomes were assessed for those patients with a PD catheter inserted radiologically. Five complications were assessed: (1) primary PD catheter malfunction, defined as inability to achieve adequate inflow or outflow to allow dialysis (in spite of laxatives and at least one attempt at PD catheter manipulation in radiology), ultimately requiring PD catheter removal; (2) pericatheter leak, defined as any escape of PD fluid from the exit site, usually detected with a moist PD exit-site dressing; (3) exit-site infection, defined as purulent drainage and redness at the PD catheter exit site and a course of oral antibiotics being prescribed by the nephrologist; (4) peritonitis, defined as symptoms and signs of peritonitis (abdominal pain and PD fluid cell count >100/μL) and a course of intraperitoneal antibiotics being prescribed by the nephrologist; and (5) death from any cause. The differences between radiological and surgical insertion groups were assessed by chi-square analysis.
analysis for dichotomous variables. Student’s t-test was used to look for differences between the two groups with respect to demographic and continuous clinical variables.

RESULTS

During the study period, 88 patients had PD catheters inserted by interventional radiologists at our center and 125 patients had catheters inserted surgically. Patient characteristics and clinical information of the patients receiving surgical or radiological catheter insertions are found in Table 1. There were no significant differences in patient demographics between radiological and surgical insertion groups at the time of PD start.

There was a significantly larger percentage of patients that received their PD catheter insertion and training as an outpatient with the newer technique of radiological insertion, compared to those that had a surgically inserted PD catheter (70% vs 32%, \( p < 0.0001 \) and 66% vs 50%, \( p = 0.0019 \) respectively) (see Table 2). At PD start, a significantly greater percentage of patients with a radiologically inserted PD catheter had an estimated GFR over 8 mL/min (82% vs 65%, \( p = 0.006 \)); they also had significantly higher serum albumin levels (38.15 vs 34.42 g/L, \( p < 0.0001 \)) and were more likely to start PD 2 weeks or longer after PD catheter insertion (79% vs 48%, \( p < 0.001 \)) compared to the surgical group.

Complications were relatively uncommon for radiological insertion. During the first 3 months, the primary outcome was lower among the surgical group. The median number of PD sets placed through a radiological technique was 2 compared to 4.5 sets in the surgical group. There was one bowel perforation, recognized with the first flush after the procedure was completed, which occurred shortly after the radiological insertions were started and was felt to be due at least in part to the newness of the technique (the patient recovered after the catheter was removed). Two subjects had hernias: none was pericatheter. The frequency of the leaks may have been linked to the placement of the deep cuff, which is different from that reported for peritoneoscopic placement with the Quill guide (Janin Group, Oswego, IL, USA), which is deep within the rectus muscle (20).

**TABLE 1**

Summary Demographics at Dialysis Initiation

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Surgical</th>
<th>Radiological</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients (n)</td>
<td>125</td>
<td>88</td>
</tr>
<tr>
<td>Gender (% men)</td>
<td>56</td>
<td>55</td>
</tr>
<tr>
<td>Age at PD start (years)</td>
<td>70.4±14.2</td>
<td>67.9±14.6</td>
</tr>
<tr>
<td>Diabetic (%)</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Caucasian (%)</td>
<td>63</td>
<td>72</td>
</tr>
<tr>
<td>BMI</td>
<td>24.3±3.9</td>
<td>25.2±5.0</td>
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<tr>
<td>Cause of ESRD (%)</td>
<td></td>
<td></td>
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<tr>
<td>Diabetes</td>
<td>36</td>
<td>34</td>
</tr>
<tr>
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<td>19</td>
</tr>
<tr>
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<td>6</td>
</tr>
<tr>
<td>GN</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Other</td>
<td>32</td>
<td>28</td>
</tr>
</tbody>
</table>

Values expressed as mean±SD or percentage.

PD catheter malfunction rate was 2.3%, PD catheter leak 9.1%, exit-site infection rate 5.7%, and peritonitis rate 11.4%. The percentage of patients that remained on PD at the end of 3 months was 72%. Of those not on PD at 3 months, the two most common reasons for technique failure were death and transfer to hemodialysis. There was no immediate operative mortality with radiological insertion. There was one bowel perforation, recognized with the first flush after the procedure was completed, which occurred shortly after the radiological insertions were started and was felt to be due at least in part to the newness of the technique (the patient recovered after the catheter was removed). Two subjects had hernias: none was pericatheter. The frequency of the leaks may have been linked to the placement of the deep cuff, which is different from that reported for peritoneoscopic placement with the Quill guide (Janin Group, Oswego, IL, USA), which is deep within the rectus muscle (20). Considering all patients, 10% (9/88) in the radiological group and 15% (19/125) in the surgical group died within the first 3 months of PD start.

**DISCUSSION**

We have attained best practice guideline targets for initiation of PD in the majority of our patients, in large part through the ease of availability and accessibility of the outpatient radiological insertion technique. While surgical insertion of PD catheters remains the most common technique worldwide, problems in some PD centers include a lack of timely access to operating facilities, operating staff, and anesthesia services (21,22), plus additional problems when residents without sufficient experience are assigned to perform the procedure (23). Surgical insertion may also often require hospitalization. A Canadian study reported an average length of...
stay of 6.75 days for an elective surgical inpatient PD catheter placement (24). In our center, radiological insertion allowed many patients to have both PD catheter insertion and PD training without a hospital admission. This was facilitated by the experience of the nurse access coordinator following a standardized pre- and post-procedure protocol that is associated with better outcomes (25). Reducing patient hospitalizations is an important priority because it reduces healthcare costs and the chances of patients acquiring a nosocomial infection (26,27). It also allows patients to continue with their daily routine at home (28,29). This could be of particular importance for the elderly, who may be more likely to require placement in a nursing home after hospitalization.

Timing of PD catheter insertion and PD start are among the most difficult challenges for nephrology healthcare practitioners involved in the care of PD patients. Best practice guidelines vary to a certain extent. While the NKF-K/DOQI (2006) guidelines focus on assessment of clinical symptoms (30), the European Best Practice Guidelines (2005) focus not only on assessment of uremic symptoms but also on assessment of GFR to plan for a PD start that is not too late, thus preventing the need for temporary hemodialysis (18). We were able to have 82% of patients start PD with an estimated GFR of >8 mL/min/1.73 m², which helps to explain why almost 80% of the patients receiving a PD catheter in intervention radiology were able to start dialysis 2 weeks or longer after PD catheter insertion. Thus, the radiological method facilitated a more planned outpatient PD start in a timely manner for most patients in our study, and most of these patients met best practice guideline recommendations.

Patients initiating dialysis are particularly at risk for malnutrition from inadequate dietary intake because of uremia and chronic inflammatory conditions (31). Poor nutrition, as evidenced by hypoalbuminemia, has been shown to be associated with reduced functional status and mortality in older patients in the general population (32). Greater patient mortality is also associated with hypoalbuminemia in those initiating either PD or hemodialysis (31,33). The NKF-K/DOQI nutrition guidelines recommend a serum albumin of 40.0 g/L for patients on dialysis (34). Our patients with radiologically inserted catheters had a mean serum albumin of 38.2 g/L at PD start, which is close to the best practice guideline of 40.0 g/L and should lead to better patient outcomes.

With respect to PD catheter complications, an editorial in *Peritoneal Dialysis International* by Danielsson noted that a reasonable benchmark for PD catheter malfunction is less than 10% (23). Our primary malfunction rate was only 2% in the radiological group, which is well below that benchmark. Examining other PD complications, a recent retrospective review of 114 patients that received a radiologically placed PD catheter using a procedure comparable to our method reported a rate of PD catheter leaks of 9.7% after PD start (35), which is comparable to ours, at 9.1%. Looking at PD catheter exit-site infections and peritonitis rates, Moon *et al.* (35) reported a PD catheter exit-site infection rate of 8.2% within the first 2 weeks after PD start and a European study reported an infection rate of 10% after PD start (36). We had comparable results in our study: our PD catheter exit-site infection rate was 6% and peritonitis rate was 11% during the first 3 months.

Limitations of our study include its retrospective nature and that the study was restricted to the first 3 months after starting on dialysis. Also, data were verified by 1 reviewer only. This was a single-center study and therefore the results might not be generalizable. Validated data on the presence of previous abdominal surgery were not available in this study but it was not an exclusion criteria for receiving a radiologically inserted PD catheter. Wait times between referral by the nephrologist and PD catheter insertion in radiology were not tracked. In general, PD catheter insertions were prioritized by the nephrologist and the access coordinator according to the urgency of the need to start PD.

In conclusion, the change in practice for the insertion of PD catheters, which included coordination by a dedicated dialysis access nurse and insertion of PD catheters by interventional radiologists, allowed more patients to achieve PD starts closer to those recommended by best practice guidelines. The change in practice was also associated with low rates of hospitalization for catheter insertions and training, as well as close to normal serum albumin levels at dialysis start.

**DISCLOSURES**

Sheldon Tobe is a minority shareholder of Dialysis Solutions Inc. and has received research funding and speaking honoraria from Baxter Healthcare Canada. The other authors have no involvements that might raise the question of bias in the work reported or in the conclusions, implications, or opinions stated.

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