Complications and catheter survival with prolonged embedding of peritoneal dialysis catheters

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Abstract

Background. Our centre uses a modification of the Moncrief technique of embedding peritoneal dialysis (PD) catheters. We undertook this study to test the hypothesis that catheter survival on PD is a function of the time a catheter is left embedded prior to use.

Methods. Data were retrospectively abstracted from review of patient records of those who received a first PD catheter over a 5-year period. Patients were divided into tertiles based on the number of days between insertion of the catheter and exteriorization to create three equal groups representing early (group 1, 11–47 days), mid (group 2, 48–133 days) and late (group 3, 134–2041 days) exteriorization strategies.

Results. 435 embedded PD catheters were inserted, 349 were exteriorized and total observation period was 5624 patient-months. Time to catheter loss was shortest in group 1 and longest in group 3 (P = 0.04). The overall rate of primary catheter failure was 6% and was significantly different in the three groups (6.9% in group 1, 1.7% in group 2 and 9.4% in group 3, P = 0.04). The time to first episode of peritonitis was longest in group 3 and shortest in group 1 (group 1 versus group 3, P = 0.009; group 2 versus group 3, P = 0.03). Adjusted peritonitis rates, however, were not different between the three groups.

Conclusions. Mechanical complications and catheter loss are associated with the length of time a catheter is embedded. We recommend insertion 6 weeks to 5 months ahead of the need for PD to maximize catheter survival.

Keywords: buried peritoneal dialysis catheter; embedded peritoneal dialysis catheter; infectious complications; mechanical complications; Moncrief–Popovich technique

Introduction

In the early 1990s, Moncrief et al. described a new technique of peritoneal dialysis (PD) catheter insertion along with a novel catheter with the goal of reducing the risk of catheter-related infections [1]. This technique calls for burying the free end of the PD catheter under the skin and leaving it embedded for 4–6 weeks before exteriorization to allow for ingrowth of tissue around the superficial cuff in a sterile environment. While there are conflicting data about the efficacy of this method in reducing rates of peritonitis [2–10], it does clearly provide for early and anticipatory creation of a PD access in much the same way as does an arteriovenous (AV) fistula for haemodialysis [11].

Our centre began to use a modification of the Moncrief technique for embedded PD catheters in 1996 [12,13]. The impetus to explore this method was the difficulty in obtaining timely PD catheter insertion due to limited surgical resources. Instead of using the Moncrief catheter, we used a standard double cuff, swan neck, coiled catheter. Our initial experience was very positive and by 2000 the vast majority of our catheters were embedded.

In our catchment area, most patients with advanced chronic renal insufficiency are followed in a dedicated Progressive Renal Insufficiency Clinic. Patients are typically referred to a surgeon for an embedded PD catheter if initiation of dialysis is anticipated within the next 6 months. When the patient is ready to start PD, the catheter is exteriorized through a small incision using local anaesthetic. The procedure is performed at the bedside in the Home Dialysis Unit by the attending nephrologist. The transfer set is then attached and the patient begins PD training the same day.

It is not known how long a PD catheter can be left embedded without increasing the risk of mechanical failure due to fibrin plugging, migration or omental wrapping. It is also unclear from the literature whether the strategy of embedding PD catheters results in a decreased risk for peritonitis, and whether the risk of infection is a function of the time the catheter is left embedded. Catheter loss may occur due to either mechanical or infectious complications, so it is possible that the length of time a catheter is embedded...
prior to externalization may impact on catheter survival. We undertook this retrospective review of our experience with embedded PD catheters to test the hypothesis that catheter survival on PD is a function of the length of time a catheter is left embedded prior to use.

Subjects and methods
The Ottawa Hospital is an academic health science centre serving a rural and urban population in excess of 1 million inhabitants. There is a single regional dialysis program that manages all end-stage renal disease (ESRD) patients as well as a multidisciplinary progressive renal insufficiency program that follows patients with stages 4 and 5 chronic kidney disease. Our method for surgical implantation and exteriorization of catheters has been previously described [12,13]. The study protocol was approved by the Ottawa Hospital Research Ethics Board.

We performed a retrospective chart review of all PD catheters inserted or externalized at the Ottawa Hospital between January 2000 and December 2005, with follow-up to 31 March 2006. A PD catheter database had been previously developed as part of a quality improvement initiative. The database included all patients having undergone first PD catheter insertion or externalization between 1 January 2000 and 31 December 2005. Specific exclusion criteria included

1. PD catheter not inserted at the Ottawa Hospital and
2. PD catheter not embedded using a modified Moncrief surgical technique.

Cases were identified by the Health Records Department using billing codes for PD catheter insertion and then cross-referenced with the clinical database of the Home Dialysis Unit (POET™, Baxter Corporation Inc., Chicago, IL, USA). Data on patients were collected by using a combination of sources, including the institution's electronic chart system (vOASIS™, DINMAR Consulting Inc., Kanata, ON, Canada), the POET database and individual paper charts. Records were reviewed for patient demographic data, surgeon, surgical technique and selected clinical outcomes. Dates of infectious and mechanical complications were entered in the database. Ambiguous or incomplete data were reviewed by committee prior to being entered in the database.

The primary study outcome was time to catheter loss. Catheter loss was defined as a removal of the catheter and transfer to haemodialysis as a result of mechanical catheter malfunction, leak, incisional hernia or infectious complication. Secondary outcomes included time to first peritonitis, peritonitis rate, proportion with primary catheter failure and proportion requiring radiologic or surgical intervention to obtain a functional catheter. Peritonitis was defined according to standard diagnostic criteria [14]. Primary catheter failure was present if a catheter was exteriorized but adequate function was not achieved within 90 days despite interventions.

Patients were divided into tertiles based on the number of days between surgical insertion of catheter and exteriorization in order to create three equal groups representing early, mid and late exteriorization strategies. Kaplan–Meier survival curves were used to evaluate catheter survival and time to first peritonitis. The starting point for the survival analyses was the date of exteriorization. Patients were followed until the event of interest occurred and were censored at the time of transplantation, death or last known follow-up. The three groups were compared using the Breslow test. Peritonitis rates were calculated using Poisson regression after controlling for age, gender and diabetes and baseline glomerular filtration rate (GFR). GFR measurements at baseline were estimated from the mean of area creatinine clearance from a 24-h urine sample calculated with the ADEQUEST (Baxter Corporation, Deerfield, IL, USA) program. Adequacy measurements were performed within 4 weeks of exteriorization of the catheter. Estimated GFRs using the MDRD [15] formula were used for those patients who did not have an adequacy measurement due to primary catheter failure. Patients for whom no estimate of GFR was available were assigned the mean GFR for their tertile for purposes of the Poisson regression. Proportion of patients with catheter failure and proportion needing intervention were compared with the chi-square test. Statistical analyses were performed using SPSS (SPSS Inc., Chicago, IL, USA) and SAS (SAS Inc., Cary, NC, USA).

Results
Between 1 January 2000 and 31 December 2005, 435 first embedded PD catheters were inserted and embedded. During this period 349 catheters were exteriorized; 50 catheters remain buried in patients who continue to be followed in progressive renal insufficiency clinic. Thirty-eight catheters were not exteriorized; 10 patients underwent pre-emptive renal transplant, 10 patients died without reaching ESRD, 11 patients chose to undergo HD instead and 1 patient relocated. Six patients required removal of their catheter before initiating PD: two because of bowel perforation and peritonitis, one at the time of surgery for a small bowel obstruction and three for other reasons.

The mean age at the time of catheter exteriorization was 60 years. Fifty-six percent of patients were male and 38% were diabetic. Thirty-seven percent of patients had ESRD due to diabetes and 24% due to ischaemic nephropathy, 17% due to glomerulonephritis and 5% because of polycystic kidney disease. Seventeen percent did not have a specific aetiology identified. Demographic features of the three groups are shown in Table 1.

As of 31 March 2006, subjects had been on PD for an average of 493 ± 448 days, with a median of 326 days. Our total post-exteriorization observation period was 5624 patient-months. The median time between catheter implantation and exteriorization was 83 days with an interquartile range of 36–222 days. When divided into tertiles, the first tertile of days embedded (group 1) was 11–47 days, the second (group 2) 48–133 days and the third (group 3) 134–2041 days. The mean GFR at the time of exteriorization for the 336 (96.2%) patients with baseline GFR data was 5.80 ± 3.89 mL/min. It was significantly different between the groups with 4.86 ± 4.01 mL/min for group 1, 6.00 ± 4.32 mL/min for group 2 and 6.51 ± 3.07 mL/min for group 3 (P = 0.003).
Complications and catheter survival

Table 1. Demographics by tertiles

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (patients)</td>
<td>116</td>
<td>116</td>
<td>117</td>
<td>349</td>
</tr>
<tr>
<td>Age (years)</td>
<td>58.9 ± 16.6</td>
<td>58.5 ± 15.8</td>
<td>62.5 ± 14.3</td>
<td>60.0 ± 15.7</td>
</tr>
<tr>
<td>GRF at exteriorization (mL/min)</td>
<td>4.81 ± 4.01</td>
<td>6.01 ± 4.32</td>
<td>6.52 ± 3.07</td>
<td>5.80 ± 3.89</td>
</tr>
<tr>
<td>Diabetes (%)</td>
<td>45.7</td>
<td>36.2</td>
<td>34.2</td>
<td>38.7</td>
</tr>
<tr>
<td>Female sex (%)</td>
<td>56.9</td>
<td>37.1</td>
<td>36.8</td>
<td>43.6</td>
</tr>
<tr>
<td>Cause of ESRD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes (%)</td>
<td>45.7</td>
<td>34.5</td>
<td>32.5</td>
<td>37.0</td>
</tr>
<tr>
<td>Vascular (%)</td>
<td>20.7</td>
<td>23.3</td>
<td>28.2</td>
<td>24.1</td>
</tr>
<tr>
<td>Glomerulonephritis (%)</td>
<td>19.0</td>
<td>18.1</td>
<td>12.8</td>
<td>16.6</td>
</tr>
<tr>
<td>PCKD (%)</td>
<td>0.9</td>
<td>4.3</td>
<td>10.3</td>
<td>5.2</td>
</tr>
<tr>
<td>Other (%)</td>
<td>15.5</td>
<td>19.8</td>
<td>16.2</td>
<td>17.2</td>
</tr>
</tbody>
</table>

Table 2. Outcomes of patients with externalized catheters (n = 349)

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technique failure</td>
<td>107</td>
<td>30.7</td>
</tr>
<tr>
<td>Peritonitis</td>
<td>33</td>
<td>31</td>
</tr>
<tr>
<td>Mechanical complications</td>
<td>35</td>
<td>33</td>
</tr>
<tr>
<td>Inadequate dialysis</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Other PD-related</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other abdominal complications</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Patient unable to cope/social reasons</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Transplantation</td>
<td>49</td>
<td>14.0</td>
</tr>
<tr>
<td>Death</td>
<td>65</td>
<td>18.6</td>
</tr>
<tr>
<td>Renal recovery</td>
<td>5</td>
<td>1.4</td>
</tr>
<tr>
<td>Still on PD at the last follow-up</td>
<td>116</td>
<td>33.2</td>
</tr>
<tr>
<td>Moved/unknown</td>
<td>7</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Technique failure and catheter loss

During the observation period, 107 (30.7%) patients transferred to HD due to technique failure. As shown in Table 2, the most common causes of technique failure were catheter loss due to peritonitis (31% of technique failure) and catheter loss due to mechanical catheter complication (33%).

Overall, 68 patients (19.5%) experienced catheter loss. Time to catheter loss was associated with time embedded prior to use. As shown in Figure 1, time to catheter loss was shortest in group 1 and longest in group 2 (P = 0.04, group 1 versus group 2).

Mechanical complications

Overall, 6% (21 of 349) of catheters were complicated by primary mechanical failure. The proportion of catheters with primary failure varied significantly with time embedded. As shown in Table 3, the proportion of catheters with primary failure was 6.9% in group 1, 1.7% in group 2 and 9.4% in group 3 (P = 0.04).

85.1% of catheters displayed good immediate function. Of those catheters with poor initial function, migration of the catheter outside the true pelvis on abdominal X-rays was noted in 19.2% of cases. Radiological manipulation or surgical revision was performed in 34 patients to improve poor initial flow. Thirteen patients underwent a radiological procedure only, 9 a surgical procedure and 12 had radiological manipulation and then surgical revision. Sixteen catheters (47%) were salvaged by these interventions. There were significantly more interventions performed in the third group (15.4%) than in the first (7.8%) or second (6.0%) (P = 0.04).

Dialysate leaks were relatively infrequent during our review periods but did occur in 26 patients (7.4% of total). The most common leak was at the exit site (9 cases), followed by genital leaks (8 cases), pleural–peritoneal leaks (7 cases) and concealed abdominal leaks (2 cases). There was no difference in the rates of leaks in the three different groups.

Infectious complications

One hundred and eighteen patients (33.6%) experienced 172 episodes of peritonitis for an overall unadjusted rate of 1 episode/33 patient-months. The time to first peritonitis was significantly longer in group 3 compared to group 1 (P < 0.01) and in group 3 compared to group 2 (P = 0.03). There was no difference in time to first peritonitis between groups 1 and 2 (P = 0.38) (Figure 2).
Fig. 2. Time to the first episode of peritonitis according to time embedded. Catheters were embedded 11–47 days in group 1; 48–133 days in group 2 and 134–2041 days in group 3. P = 0.38 for comparison between group 1 and group 2; P = 0.01 for group 1 versus group 3 and P = 0.03 for group 2 versus group 3.

On multivariate analysis, GFR was significantly associated with peritonitis rate (P < 0.0001) but age (P = 0.10), gender (P = 0.77) and diabetes (P = 0.97) were not. On multivariate analysis controlling for age, gender, diabetes and GFR, the groups had the following adjusted peritonitis rates: group 1, 1 per 29 patient-months (0.035 episodes/month, 95% CI 0.027–0.045 episodes/month); group 2, 1 per 33 patient-months (0.030 episodes/month, 95% CI 0.023–0.039 episodes/month) and group 3, 1 per 38 patient-months (0.026 episodes/month, 95% CI 0.019–0.034 episodes/month). None of the three adjusted rates were significantly different from each other: group 1 versus group 2 (P = 0.44); group 1 versus group 3 (P = 0.13) and group 2 versus group 3 (P = 0.40).

Discussion

The major novel finding in this study of embedded PD catheters is that catheter survival on PD is associated with the length of time that a PD catheter is left embedded, with the longest time to first peritonitis seen in patients with catheters embedded for >5 months and the shortest time seen in those patients with catheters embedded for <6 weeks. Adjusted peritonitis rates also decline with a longer time embedded but the differences are not statistically significant.

The findings on mechanical complications and catheter survival suggest that there is an ideal time window for exteriorization and use of an embedded catheter. The higher risk of mechanical catheter complications in the third group (>5 months) suggests that the risk of fibrin plugging, migration and omental wrapping of catheters increases with the time that a catheter is not in use. Early use of a catheter was also associated with a higher risk of primary catheter failure for reasons that are not clear, but does not appear to be related to dialysate leaks.

Our findings on infectious complications are important as they may help address some of the controversy surrounding the putative decrease in peritonitis rates with embedded catheters. Moncrief and colleagues first promoted the technique of embedding catheters as a means of reducing the risk of peritonitis by allowing the subcutaneous portion of the catheter to heal in a sterile field. This hypothesis was supported by initial data of retrospective and non-randomized nature [2–6], but was not confirmed by randomized controlled trials [7,8]. Our data raise the possibility that the standard healing time of 4–6 weeks used in these studies may not be long enough to allow for an optimal antimicrobial barrier to form. Time to first peritonitis increases with increased length of time embedded suggesting that a well-healed and mature tunnel may lead to less early peritonitis. We cannot, however, draw firm conclusions as baseline differences in co-morbidity and GFR may have accounted for some of this observed difference. Indeed, when our peritonitis rates were adjusted for these factors there was no statistically significant difference in peritonitis rates between the groups. Given the significant increase in mechanical complications with prolonged (>5 month) embedding of PD catheters, we would not recommend prolonged embedding of PD catheters as a strategy to decrease the risk of peritonitis. Similar to a previously published study, we found that GFR was a significant predictor of peritonitis rate [16].

The major limitation to our findings relates to the retrospective design of this study. It is certainly possible that there exist specific physician or patient factors that might impact on the timing of PD catheter insertion and that these same factors may have had an independent effect on the outcomes of interest. It should be noted that there were minor differences in co-morbidities among the three groups that might also have affected outcomes. We were able to adjust
our peritonitis rate data for age, sex, diabetes and GFR but more detailed co-morbidity data were not available to allow for further adjustment of our results.

Notwithstanding the stated limitations, our findings are important for a number of reasons. This is the largest reported series of outcomes with embedded catheters. An 85% rate of good initial function and a 6% rate of primary catheter failure provide reassurance that the strategy of early insertion of PD catheters is not associated with higher risk of mechanical complication than traditional techniques [17,18]. Moreover, even catheters that are left embedded for >5 months had an acceptable rate of primary malfunction of 9.4%—also a reassuring finding [19]. Although there is a theoretical risk of bowel erosion and perforation associated with early PD catheter implantation, we found that these occurrences were extremely rare with only two cases in 435 patients. In neither of these cases could it be determined with certainty if the bowel perforation occurred at the time of surgical implantation or subsequently due to erosion of the catheter into the bowel. With respect to infectious complications, our overall peritonitis rate of 1 per 33 patient-months is better than recommended benchmarks [14,20]. Thus, our findings suggest that embedded catheters perform well overall with respect to infectious and mechanical complications.

This study, most importantly, provides guidance for the optimal length of time to leave a catheter embedded prior to use. Mechanical failure of the catheter and peritonitis are leading causes of transfer from PD to haemodialysis [21,22] and this study suggests that both are associated with the length of time that a catheter is embedded prior to use. Mechanical complications are not linearly associated with time and appear to be minimized when a catheter is exteriorized between 6 weeks and 5 months. Time to first peritonitis is a more linear function of time embedded and is least frequent if a catheter is exteriorized after 5 months though baseline differences in the groups studied diminishes the strength of this finding. Overall, we recommend a strategy of inserting an embedded PD catheter and implantation technique. Perit Dial Int 1993; 13(Suppl 2): S329–S331

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Acknowledgements. The authors are grateful to the late Dr Denis Page for pioneering and encouraging the use of embedded PD catheters at the Ottawa Hospital, and for promoting the academic mission of our Home Dialysis Unit.

Conflict of interest statement. None declared.