



## Outcomes after peritoneal dialysis catheter placement<sup>☆,☆☆</sup>



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### ABSTRACT

**Background:** The purpose of this study was to review surgical outcomes after elective placement of peritoneal dialysis (PD) catheters in children with end-stage renal disease.

**Methods:** Children with PD catheters placed between February 2002 and July 2014 were retrospectively reviewed. Outcomes were catheter life, late (>30 days post-op) complications (catheter malfunction, catheter malposition, infection), and re-operation rates. Comparison groups included laparoscopic versus open placement, age < 2, and weight < 10 kg. Univariate and multivariate analysis were performed.

**Results:** One hundred sixteen patients had 173 catheters placed (122 open, 51 laparoscopic) with an average patient age of  $9.7 \pm 6.3$  years. Mean catheter life was similar in the laparoscopic and open groups ( $581 \pm 539$  days versus  $574 \pm 487$  days,  $p = 0.938$ ). The late complication rate was higher for open procedures (57% versus 37%,  $p = 0.013$ ). Children age < 2 or weight < 10 kg had higher re-operation rates (64% versus 42%,  $p = 0.014$  and 73% versus 40%,  $p = 0.001$ , respectively). Adjusted for age and weight, open technique remained a risk factor for late complications (OR 2.44, 95% CI 1.20–4.95) but not re-operation.

**Discussion:** Laparoscopic placement appears to reduce the rate of late complications in children who require PD dialysis catheters. Children <2 years age or <10 kg remain at risk for complications regardless of technique.

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Peritoneal dialysis (PD) was developed as an alternative to hemodialysis in patients with renal disease and is considered the mainstay for renal replacement therapy in children when dialysis is required. In 1968, Tenckhoff and Schechter designed a cuffed silicone rubber PD catheter that provided the basis for the current design of catheters used for the long-term effective treatment of renal failure [1]. Subsequent modifications to the shape and structure of peritoneal dialysis catheters have reduced many of the complications associated with chronic indwelling catheters. Advancements and standardization in the surgical technique and placement of PD catheters have also helped reduce complication rates. The Canadian Association of Pediatric Nephrologists (CAPN) and Peritoneal Dialysis Working Group have recommended that exit sites should be oriented either downward (preferred) or laterally in children; in addition, children should have a PD catheter with a curled intraperitoneal segment [2,3]. The evidence for use of swan neck versus straight catheters or single versus double cuffed catheters is not strong and remains a debated topic [2,4].

Despite the advancements in PD more than the past fifty years, there are still significant complications associated with chronic indwelling catheters. The most common complications associated with PD continue to be catheter infections and peritonitis. Complications such as obstruction, non-functioning or malpositioned catheters, and leakage occur commonly in children [5,6]. The purpose of this study was to review our experience with placement of peritoneal dialysis catheters at a relatively high volume institution, including the effect of adopting minimally invasive techniques for catheter placement.

### 1. Methods

#### 1.1. Study design

Data from all patients who underwent PD catheter placement at Texas Children's Hospital between February 1, 2002 and July 1 2014 were reviewed retrospectively. Patients were identified from the hospital's surgical database through procedure codes. Neonates with non-tunneled temporary peritoneal dialysis catheters and patients with acute renal failure were excluded. Children with previous renal transplantation or abdominal surgery were not excluded. Data collected consisted of the following patient variables: demographics, dialysis use prior to insertion, surgical technique, catheter type, duration of catheter use, ultimate renal disposition, and complication rates. Patients who

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underwent laparoscopic and open surgery were compared. The primary outcome was catheter life.

### 1.2. Operative procedures

Eight board-certified pediatric surgeons performed all catheter placements under general anesthesia. Operations were performed open or laparoscopically according to surgeon preference. When omentectomy was performed the omentum was most commonly delivered through the open or port incision with subsequent ligation of the segment using sutures, monopolar electrocautery, or bipolar harmonic electrocautery. All omentectomies were classified as partial except one, performed without exteriorizing the omentum, in which a complete omentectomy was detailed in the surgeon's operative report. For patients who remained on peritoneal dialysis at the time of last follow up or at the time of death, the date of last follow up or death was substituted as the end point for catheter life calculations. Complications included peritonitis, malposition, malfunctioning, or tunnel infection. Complications were stratified into early (less than 30 days from insertion) or late (greater than 30 days from insertion). Functional catheters removed for renal function recovery, transplantation, or at the time of mortality were not deemed failures. Renal transplantation rates were reviewed to determine successful bridge-to-transplantation.

### 1.3. Statistical analysis

Descriptive catheter data were calculated using simple statistics. Chi-square tests were performed on binomial data. Multivariable logistic regression, adjusting for age and weight, was used to assess complication and reoperation rates between the open and laparoscopic techniques. Kaplan–Meier curves were used to determine differences in catheter life between the two surgical approaches.

## 2. Results

### 2.1. Demographics and surgical outcomes

During the study period, 116 patients had 173 catheters placed (122 open, 51 laparoscopic). Patient demographics and catheter characteristics are listed in Table 1. Patients ranged in age from 2 days to 22 years with an average age of  $9.7 \pm 6.3$  years. Overall, patients with open catheter placement were younger ( $9.0 \pm 6.5$  years) compared to the laparoscopic group ( $11.4 \pm 5.7$  years,  $p = .024$ ). However, both groups had a similar number of children younger than age 2 (25% vs. 16%,  $p = 0.08$ ). Focal segmental glomerular sclerosis and congenital renal dysplasia accounted for 32% of the patients with ESRD at our institution (Table 2).

There were 3340.5 total months of peritoneal dialysis. The total mean catheter life was  $579 \pm 519$  days and was similar in the laparoscopic and open groups ( $581 \pm 538$  vs.  $575 \pm 479$  days,  $p = 0.941$ ) (Table 3). The average time to first use was  $32 \pm 61$  days and was similar in the laparoscopic and open placed catheters ( $29 \pm 60$  vs.  $34 \pm 62$  days respectively,  $p = 0.635$ ). Omentectomy was performed at a similar rate in both the laparoscopic (34%) and open (34%) groups ( $p = 0.562$ ). Fifty-nine patients were successfully bridged to transplant (51%). Sixteen patients died during the study period related to their

**Table 2**  
Indications for Peritoneal Dialysis.

Indication	N (%)
FSGS	29 (17)
Renal dysplasia	25 (15)
Failed renal transplant	17 (10)
Posterior urethral valves	13 (8)
Polycystic kidney disease	11 (6)
Reflux nephropathy	7 (4)
MPGN	4 (3)
Lupus	3 (2)
Congenital nephrotic syndrome	3 (2)
Aminoglycoside toxicity	3 (2)
Cisplatin toxicity	2 (1)
p-ANCA	2 (1)
Obstructive nephropathy	2 (1)
IgA nephropathy	2 (1)
Unknown/Other	50 (29)

FSGS, Focal segmental glomerular sclerosis;  
MPGN, Membranoproliferative glomerulonephritis.

chronic medical condition. There were no deaths related to the operative procedure or catheter complications.

### 2.2. Complications and re-operations

The overall complication rate was 1 in 19.5 dialysis months. The most common complication was peritonitis (37%), defined by patient receiving oral or IV antibiotics, followed by tunnel/skin infection (29%), malfunction (clotted, leaking, or broken catheter) (24%), malposition (7%), and others (3%). The early complication rate was similar in laparoscopic and open procedures (17% vs. 13%,  $p = 0.570$ ); however, the late complication rate was higher in those with an open insertion (57% vs. 37%,  $p = 0.020$ ) (Table 3). There was no difference in early or late complications in patients who received an omentectomy when compared to those who did not undergo an omentectomy ( $p > 0.30$ ). Omentectomy did not change the re-operation rate ( $p > 0.99$ ) nor the rate of mechanical complications ( $p = 0.50$ ) and infectious complications ( $p = 0.14$ ). In only one patient was omentum the direct cause of catheter malfunction. Eighty-one catheters (47%) required re-operation for complications. This equates to 1 operation for every 41.2 dialysis months. Of the laparoscopic cases, 18/51 patients (35%) required multiple operations yielding a significantly lower re-operation rate with laparoscopy than with an open approach (25% vs. 78%,  $p = 0.046$ ).

### 2.3. Age-based outcomes

Age < 2 years was a significant risk factor for catheter malfunction. Catheters in children < 2 years of age had a significantly lower mean catheter life of  $352 \pm 442$  days vs.  $645 \pm 523$  days in children > 2 years of age ( $p = 0.002$ ) (Table 4). Children < 2 years had an overall higher rate of early complications than older children (36% vs. 10%,  $p < 0.001$ ) however there was no difference in rates of late complications when compared to older children ( $p = 0.10$ ). Children < 2 years had significantly higher rates of re-operation (66% vs. 42%,  $p = 0.02$ ) given a higher proportion of malpositioned catheters requiring surgical intervention (15% vs. 5%); nearing but not reaching statistical significance ( $p = 0.07$ ). The proportion of laparoscopic procedures in both

**Table 1**  
PD Catheter Patient Demographics.

Patient characteristic	Total (n = 173)	Laparoscopic (n = 51)	Open (n = 122)	P value
Average age – years (SD)	$9.7 \pm 6.3$	$11.4 \pm 5.7$	$9.0 \pm 6.5$	0.024
Patients < 2 years of age (%)	38 (22)	8 (16)	30 (25)	0.080
Male patients (%)	96 (56)	27 (28)	69 (72)	0.393
Average weight – kg (SD)	$32.9 \pm 22.7$	$38.7 \pm 21.9$	$30.4 \pm 22.7$	0.032
Omentectomy performed (%)	58 (34)	17 (34)	41 (34)	0.562

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