Journal of Pediatric Surgery 53 (2018) 640–643

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

Obstruction of peritoneal dialysis catheter is associated with catheter type and independent of omentectomy: A comparative data analysis from a transplant surgical and a pediatric surgical department

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ARTICLE INFO

Article history:
Received 19 February 2017
Received in revised form 29 June 2017
Accepted 30 June 2017

Key words:
Catheter
Kidney insufficiency
Obstruction
Peritoneal
Dialysis
Surgical complication

ABSTRACT

Background: Peritoneal dialysis (PD) catheter occlusion is a common complication with up to 36% of catheter obstructions described in the literature. We present a comparison of complications and outcome after implantation of PD catheters in a transplant surgical and a pediatric surgical department.
Methods: We retrospectively analyzed 154 PD catheters, which were implanted during 2009–2015 by transplant surgeons (TS, University Medical Center Hamburg-Eppendorf, Germany, n = 85 catheters) and pediatric surgeons (PS, Charité University Medicine Berlin, Germany, n = 69 catheters) in 122 children (median (range) age 3.0 (0.01–17.1) years) for acute (n = 65) or chronic (n = 89) renal failure. All catheters were one-cuffed or double-cuffed curled catheters, except that straight catheters were implanted into smaller children (n = 19) by TS in Hamburg.
Results: Patient characteristics and operation technique did not differ between the departments. Peritonitis was the most common complication (33 catheters, 21.4%). Leakage (n = 18 catheters, 11.7%) occurred more often in children weighing <10 kg ($p < 0.001$). The incidence of obstruction and dysfunction was significantly higher in catheters used in PS than catheters used in TS (30.4% vs. 11.8%, $p = 0.004$). Omentectomy did not reduce the incidence of catheter obstruction ($p = 1.0$). Perforation at the catheter tips was larger and appeared to be rougher in catheters used in PS than the catheters in TS.
Conclusions: The type of catheter and presumably the type of perforation at the catheter tip may influence the incidence of peritoneal dialysis catheter obstruction.

Acute renal failure (ARF) and chronic renal failure (CRF) are uncommon in children. The incidence of CRF is estimated to be 12.1 cases/million, but the incidence of ARF is difficult to define, as it is often managed conservatively by ICU staff [1,2]. Peritoneal dialysis (PD) is the preferred method when dialysis is necessary in children [2]. It enables dialysis in hemodynamically unstable patients and small children including neonates [3]. Furthermore, no vascular access and no anticoagulation are needed [2]. Despite PD implantation being considered a safe technique, surgical complications during the first 60 days after implantation are estimated to be as high as 40% [4–6]. Obstruction, infectious complications, leakage, and dislocation are the most common complications [4–8]. The incidence of complications is higher in children with a weight less than 10 kg [4,9]. There has been a debate in the literature about whether omentectomy reduces the rate of dialysis catheter obstruction and performance of omentectomy depends on surgeons' preference [2,4–6,8,10].

We previously reported the complication rate in pediatric patients at a department of hepatobiliary and transplant surgery [11]. Here we present the first comparison of complications and outcome after

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http://dx.doi.org/10.1016/j.jpedsurg.2017.06.028
0022-3468/

implantation of peritoneal dialysis catheter by transplant surgeons vs. pediatric surgeons at two German hospitals. We posed the question, whether operation technique and type of catheter had an effect on the complication rates.

1. Methods

This is a two center retrospective study of all peritoneal dialysis catheters that were implanted in patients <18 years of age, from January 2009 until August 2015, at the Department of Hepatobiliary and Transplant Surgery at the University Hospital of Hamburg-Eppendorf, in Hamburg, Germany, and at the Department of Pediatric Surgery at the Charité University Medicine Berlin, in Berlin, Germany. A total of 154 PD catheters were included in the analysis.

At the University Hospital of Hamburg-Eppendorf, peritoneal dialysis catheters were one-cuffed or double-cuffed, either straight with a length of 31 cm (Covidien Neonatal; Covidien; Mansfield, MA, USA) or curled with a length of 39 cm (Argyle Curl Cath Peritoneal Catheter or Kendall Quinton Curl Catt; Covidien; Mansfield, MA, USA). The nephrologist and surgeon together estimated the catheter length by taking the distance between the umbilicus and symphysis into account. At the Charité University Medicine in Berlin peritoneal dialysis catheter were always curled and one-cuffed or double-cuffed Joline PD catheters with different lengths (Joline GmbH, Hechingen, Germany). The nephrologists chose the catheter length by measuring the distance between the umbilicus and symphysis and then subtracting 2 cm to obtain the curl-to-cuff distance.

Acute renal failure (ARF) was defined as the necessity of dialysis within the first three months, whereas chronic renal failure (CRF) was defined as need for renal replacement therapy any time thereafter.

Every PD catheter implantation was performed by a specialist of either general or pediatric surgery. At both centers, implantations of peritoneal dialysis catheters were performed through an open approach; a laparoscopic technique was not used. Omentectomy was performed as a partial omentectomy through the open incision by delivering the omentum until tension was achieved and coagulation or ligation of the visible part of the omentum. The catheter was implanted with a downward pointing direction so that the tip was oriented retrovesically. A purse-string suture often sutured the first Dacron cuff to the peritoneum. Every catheter was tunneled through the abdominal wall over a distance of several centimeters to a separate exit site. The second cuff was located in the tunnel. At the end of the operation, every catheter was tested for water-tightness with approximately 10 ml/kg body weight dialysis solution. At both centers, parents received catheter care education by a dialysis nurse during the hospital stay. The education was structured and documented on special forms. To prevent infections, parents were taught the handling of the catheter (e.g. the nontouch technique) and were educated about surroundings. Parents were trained to recognize catheter-associated infections by using a scoring system. In cases of complications, catheter care education was repeated to eliminate any misconduct. At both centers, dialysis nurses and pediatric nephrologists were available around the clock in case of problems.

Data about the surgeon, the operation technique, the duration of the operation, the type of catheter, and the performance of partial omentectomy were obtained from the surgery reports. Medical charts were analyzed for weight at operation, sex, diagnosis, date on which dialysis was started, date of catheter explantation, and complications during the first 6 months after implantation. Peritonitis was defined as a positive microbiological culture of dialysate or a high leucocyte count in the dialysate (>100/μl). Wound infection and leakage were detected by physician examination. Obstruction and dislocation were diagnosed either by the surgeon during revision or by clinical or radiological examination (x-ray). Revision was any reoperation performed under general anesthesia.

Magnification of peritoneal dialysis catheters was performed with a microscope (Ultra microscope II (Light Sheet Microscope), magnification 1.26).

1.1. Statistical analysis

Categorical variables were compared using a chi-square test and were presented as frequencies and percentages. Continuous variables were analyzed using an unpaired *t*-test and were reported as mean ± standard deviation (SD) values. Age was summarized as median and range. Data were statistically analyzed with SPSS version 22 (IBM; Armonk, NY, USA). A *P* value ≤0.05 was considered significant.

2. Results

2.1. Patient characteristics

In the study period, transplant surgeons implanted 87 peritoneal dialysis catheters in 74 children (37 boys, 37 girls) of which two catheters were never used and therefore excluded from further analysis. During the same period, pediatric surgeons implanted 69 catheters in 50 children (29 boys, 21 girls). At the department of transplant surgery, 9 specialists implanted a total of 85 catheters. Five surgeons implanted more than 10 PD catheters each, and 4 surgeons implanted less than 10 catheters each. At the department of pediatric surgery, 9 specialists implanted a total of 68 catheters. Four surgeons implanted more than 12 catheters each, and 5 surgeons implanted 1–6 PD catheters each. The patient characteristics and operation technique did not differ between the departments (Table 1). Sixty-five catheters were implanted owing to acute renal failure, and 89 catheters were implanted owing to chronic renal failure. The most common cause for ARF was hemolytic uremic syndrome (n = 53, 81.5%), followed by rare causes such as infectious diseases (n = 7), heart disease (n = 3) and metabolic disease (n = 2). Congenital anomalies of the kidney and urinary tract were the reason for CRF in most cases (n = 41, 46.1%), followed by polycystic kidneys (n = 16, 18.0%), chronic kidney damage after hemolytic uremic syndrome (n = 12, 13.5%) and focal segmental glomerulosclerosis (n = 12, 13.5%). The median (range) age at catheter implantation was 3.0 (0.01–17.1) years.

2.2. Peritoneal dialysis catheter complications

During the first 6 month after implantation peritonitis was the most common complication (21.4% of peritoneal dialysis catheter). The second most common complication was obstruction/dysfunction, which occurred in a total of 31 peritoneal dialysis catheters (20.1%). Obstruction/dysfunction occurred in 21 out of 69 PD catheters in pediatric surgery (PS; 30.4%) and in 10 out of 85 PD catheters in transplant surgery (TS; 11.8%; $p = 0.004$, Table 2). When analyzing the children's weight, there was no significant difference between the departments for obstruction in children weighing <10 kg ($p = 0.58$). In children weighing

Table 1
Patient characteristics in transplant surgery (TS) and in pediatric surgery (PS).

	TS (n = 85)	PS (n = 69)
Median age [years]	2.52 (range 0.00–15.5)	3.23 (range 0.03–17.1)
Male [n]	47 (55.3%)	45 (65.2%)
Female [n]	38 (44.7%)	24 (34.8%)
Children's weight [kg]	17.7 ± 16.2	18.5 ± 12.2
Acute renal failure [n]	39 (45.9%)	26 (37.7%)
Chronic renal failure [n]	46 (54.1%)	43 (62.3%)
Explantation of a catheter at the time of implantation [n]	17 (20.0%)	19 (27.5%)
Duration of operation [min]	49.7 ± 21.5	55.3 ± 21.0
Lifetime of catheter [days]	110.6 ± 215.0	84.8 ± 184.5