

Evaluation of Complications of Peritoneal Dialysis Catheter in Children: A Retrospective Single Center Study

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Abstract

Introduction: Peritoneal dialysis is a long-term method of dialysis for children. Peritoneal dialysis, when performed effectively, saves valuable time for children with advanced kidney transplant, till they reach the appropriate age for the kidney transplant. In children, due to their rapid physical growth and the large catheter size, as well as the thin and weak abdominal wall, especially before the age of 4, the complications of catheterization such as catheter leak and incisional hernia are higher than that of adult population. In this study we aim to evaluate the dysfunction and complications of the catheters of peritoneal dialysis in children.

Materials and Methods: We assessed medical records of all patients, who underwent peritoneal dialysis since 2006 till 2015 at Mofid hospital, Tehran, Iran. Total number of 41 records were evaluated, of which 11 cases were excluded due to incomplete data and 30 patients were analyzed eventually. Complications of catheter were recorded.

Results: We studied 30 patients, 14 males and 16 females; the mean age of the children was 72.6 months (5 to 12 years old). The leading cause of end stage renal disease (ESRD) were primary glomerulopathies. There were total of 3 catheter replacements, mostly due to peritonitis and catheter obstruction. The incidence of infectious complications was 40.3%. The incidence of all complications was 1 out of 6.4 patients/month.

Keywords

- Peritoneal dialysis
- Infectious
- Complications
- Catheter
- Pediatrics

Conclusion: Regarding the high prevalence of catheter-related complications in children undergoing chronic peritoneal dialysis, especially infectious complications, adopting standard surgical technique of catheter insertion accompanied by well trained peritoneal dialysis team is essential to prevent the complications and to increase the functional life span of the catheter and to enhance the quality of life of the patient.

Introduction

Chronic renal insufficiency (CRI) is defined as a condition, in which the kidneys' function remains below normal level for more than three months. These children need a route for lifelong dialysis. Two modes of dialysis are common; one is the hemodialysis, and the other is peritoneal dialysis. Nine percent of all dialyses in the world is done via the peritoneal route, with higher prevalence in countries such as Mexico and Thailand and less popularity in countries such as Japan, Brazil, Germany, India, Turkey and Egypt.¹ There are two types of peritoneal dialysis (PD): Continuous Ambulatory Peritoneal Dialysis (CAPD) and Automatic Peritoneal Dialysis (APD)², of which only the first one is performed in Iran. However, Continuous ambulatory peritoneal dialysis (CAPD) is the preferred method of treatment among newborns and children dealing with chronic kidney disease (CKD) as if it is done effectively, patients will be ready for future kidney transplant. Chronic peritoneal dialysis is a common procedure among ESRD patients in Asia (especially Japan), Europe, northern and southern America. By using different techniques, 10-year survival of patients is now above

70% and peritonitis occurrence rate has decreased to 1.3 patients in 13 months of disease course.²⁻⁵ CRI has a prevalence of 1.4% among children under 18 years old in Iran,⁶ and there are 1624 cases going under PD in 70 centers in the country based on statistics published in 2016 which means a 2 percent annual rise. However, the annual rise of ESRD cases is higher (4-5%).⁷ Catheterization is done to establish a route for peritoneal dialysis. However, it has some infectious and non-infectious complications with the latter being intra-abdominal pressure rise due to injection of Dialysate (dialysis solution) leading to leakage and abdominal wall hernia and rise of blood glucose due to absorption of Dialysate. Compared to adult group, the prevalence of these complications are higher among children especially under the age of 4 due to their thinner, more fragile abdominal wall and their rapid physical growth leading to inadequacy of the diameter of catheter in proportion to the size of the child.⁸ Other complications are bacterial peritonitis, intra-abdominal hemorrhage and catheter dysfunction due to obstruction.⁹ 10 Non-infectious complications can be further categorized as⁹:

A) Complications related to catheterization process:

1. Visceral perforation
2. Bleeding
3. Catheter obstruction
4. Outlet leak
5. Pain sensation throughout dialysis

B) Complications related to rise of abdominal pressure:

1. Hernia
2. Pleural leak (hydrothorax)
3. Back pain

C) Complications related to altered metabolism:

1. Hyperglycemia
2. Hypertriglyceridemia
3. Hyperinsulinemia
4. Hyperleptinemia

D) Others:

1. Hemoperitoneum
2. Encapsulated peritoneal sclerosis

Currently, up to 20% of cases receiving PD need hemodialysis at a point due to complications mentioned above. Hence, detecting these complications in a timely manner could be pivotal.^{2, 3}In a study done in united states among children between 2004 and 2011, there were no significant correlation between the rate of catheter

site infection and gender, ethnicity, type of underlying renal disease, catheter cuff number or its mobility, presence of gastrostomy-tube, stoma or vesicostomy.¹¹ There is a 0.25% rate of infection distant from surgical site during dialysis. Older age and accurate surgical site care lower the rate of infection. These infections are treatable but can cause further complications.¹²

In Iran there is still a high rate of mortality and morbidity especially peritonitis in comparison to other countries. This study has sought to determine the epidemiologic features of children who underwent chronic peritoneal dialysis at Mofid hospital; a referral therapeutic center in Tehran, Iran, to identify the complications leading to catheter malfunction. We hope this study leads us to a better and safer technique for dialysis for ESRD patients, especially children.

Materials and Methods

Our study's results are based on retrospective analysis of children who underwent peritoneal dialysis since April 1st, 2006 till December 30th, 2015 at Mofid children's hospital. Mofid Children's Hospital is a tertiary referral center with 261 beds, which is one of the major referral hospitals of children in the country. This study aims to evaluate the rate of morbidity and mortality, peritoneal catheter related complications and catheter dysfunctions. This research has been approved ethically by the ethics committee of Shahid Beheshti University of Medical Science (SBMU).

Clinical charts, nursing records and laboratory results of patients who underwent peritoneal dialysis

were assessed. Demographic and anthropometric information and clinical characteristics were extracted via data collection forms, pre-designed by the researcher. Two researchers separately analyzed and double checked the collected information. Missing data were collected by direct contact of medical researchers with family members of the patients. All patients were included whether they had a final status of receiving kidney transplantation or expired. Six patients out of 41 were excluded due to insufficient laboratory and clinical information and the final status of 5 cases were not determined. On overall 30 patients entered the study.

Pain assessment: The Verbal Rating Scale (VRS), has been utilized to evaluate the severity of pain, **0**; no pain at all, **1**; mild pain, **2**; moderate pain, **3**; severe pain, **4**; worst pain. **Body Mass Index (BMI);** obtained by division of body weight in kilograms by height in meters squared (kg/m^2), **obstruction of catheter:** was identified by the surgeon, **catheter infections:** was accomplished considering the presence of inflammation signs and symptoms.

The data of all patients who underwent peritoneal dialysis since April 1st, 2006 till December 30th, 2015 at Mofid children's hospital was included. All the information including age, sex, BMI, prematurity, past medical history, catheter insertion techniques using open surgical approaches, laparoscopic and percutaneous techniques, perioperative factors such as; omentectomy,

gastrostomy, the time of dialysis initiation after catheter insertion (hour), and final status (expired or kidney transplantation) were investigated.

Categorical and continuous variables have been respectively defined as n [%] and mean standard deviation. Then, we utilized the χ^2 test, or Fisher's exact test to compare the differences between categorical data when possible. To evaluate the risk factors related to death within hospital, univariable and multivariable logistic regression models were applied. A two-sided α smaller than 0.05 were defined as statistically meaningful. Thorough statistical calculations have been done by Statistical Package for Social Sciences (SPSS), (version: 20).

Results

Overall, 30 cases who underwent peritoneal dialysis (PD), have been included in this study. These 30 cases were comprised of 14 (49.1%) males and 16 (50.9%) females; the mean age was 72 ± 6 months, ranged 5 to 12 years old, the average duration of treatment was 12 ± 14.3 months **Table 1**. The leading causes of ESRD were glomerulopathies within 12 cases (39%), while other etiologies consisted 8 cases (28%) of renal hypo/dysplasia with or without urologic obstruction, 6 cases (22%) of familial nephropathies, 2 cases (5%) of kidney tumors, and unknown etiologies accounted for the rest (3 cases (6%)).

Table1: The comparison of demographic characteristics between catheters related complications group and group with no catheter complications.

variables	Catheters related complications group	No catheter complication group	P value
Age(months) \pm standard deviation	16.85 \pm 6.7	52.61 \pm 6.85	$P=0.004$
Sex (n=male)	7	5	$P=0.89$
BMI* \pm standard deviation	18.8 \pm 3	14.2 \pm 2	$P=0.59$
*Body Mass Index (BMI).			

Catheter obstruction was seen in 3 of total 30 cases, of whom omentectomy had not been done during catheter insertion in two patients. ($P=0.004$), **Table2**. In our research differences of statistical significance were not observed between age and PD catheter related complications. The duration of an PD catheter functionality was 80% in 12 months, 62% in 24 months and 58%

in 36 to 48 months of follow up. A significant higher rate of catheter survival had observed in children with older age ($P=0.03$), as shown in **Figure.1**. In the current study, the main cause of PD catheter removal was peritonitis (26%) in the group suffering catheter associated complications, and Kidney transplantation in the group with no catheter complications as shown in **Table 3**.

Table 2: The frequency of peritoneal dialysis catheter complications in 30 cases

Type of complications	n, (%)
Catheter perforation	2 (6%)
Bleeding around catheter	3 (9%)
Obstruction of catheter	3 (9%)
Severity of pain during catheter insertion and drainage, n=26	No pain at all; 3 (7%) Mild pain; 9 (33%) Strong pain; 7 (24%) Worst pain; 7 (24%)
Incisional hernia	1 (0.45%)

Back pain after catheter insertion, n=29	No pain at all; 8 (7%) Mild pain; 9 (33%) Moderate pain; 7 (24%) Strong pain; 5 (16%)
Intestinal obstruction	2 (0.6%)
Peritonitis	12 (40%)
Hydrocele	1 (0.45%)

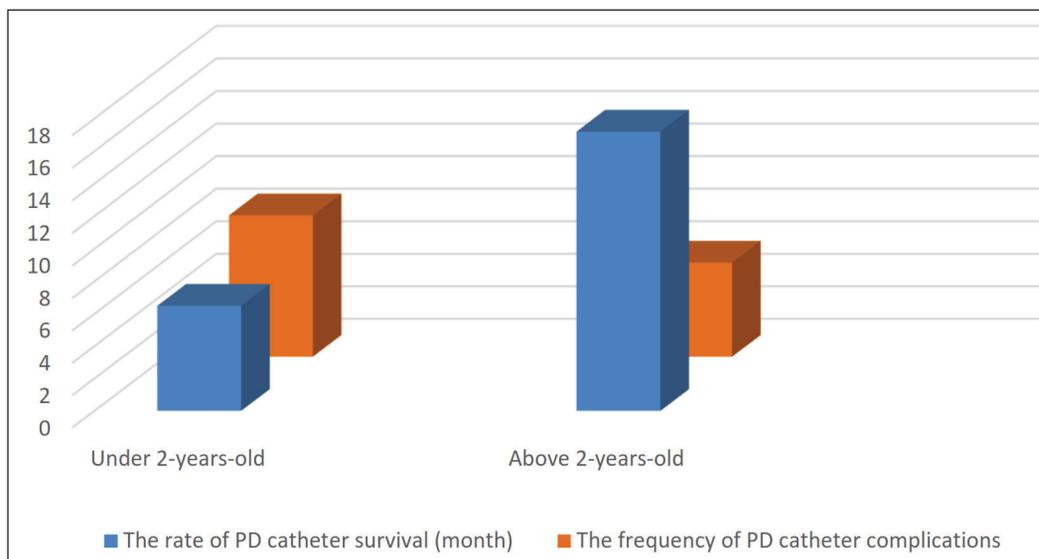


Figure 1: The frequency of PD catheter complications regarding the patients ages.

Table 3: The frequency of PD catheter removal causes in group with catheter complications and no catheter complications.

Group with PD catheter associated complications		Group with no PD catheter associated complications	
<i>Causes</i>	(%)	<i>Causes</i>	(%)
Death	3%	Death	19%
Peritonitis	26%	Kidney transplantation	33%
Catheter extracted	8%	Hemodialysis	3%
Obstruction of catheter	1%	Cessation of PD	3%
Hydrocele	1%	Admission to Another center	1%
Intestinal obstruction	1%	Others	1%

Discussions

In our study, we retrospectively studied children diagnosed with ESRD, who used to receive PD via intraperitoneal catheter between 2004 and 2015. Most prevalent cause of ESRD among our patients was primary glomerulonephritis in general. There are only two studies with the same aim, done in Iran. One has included all children who were under peritoneal dialysis at 3 referral centers (Children's medical center, Mofid hospital and Ali Asghar children's hospital) between 1993 and 2004 with the results demonstrating hernia, leak and other non-infectious complications being the most common complications of catheterization. Peritonitis incidence was 4.1 patients in every 85 months of dialysis. Factors leading to peritonitis were age under 12 years, using Tenckhoff catheter and lower Body Mass Index (BMI). When peritonitis occurred, culture results were compatible with 32% for gram positive organisms, 28% for gram negative organisms, 10% for fungi and in 30%, cultures were negative.¹³In the other Iranian study, all children under 14 years old who received peritoneal dialysis in 9 nephrology departments between 1993 and 2006 were included in a cohort study. In the study, 182 intraperitoneal dialysis catheters were used for dialysis of 120 children in the course of their treatment. Most prevalent cause of catheter replacement was catheter outlet fracture due to inflammation, adhesion or dislocation.⁷Strategies to prevent these complications include choosing the proper size catheter and appropriate surgical strategy and performing adequate postoperative care. Close cooperation among surgical team and nephrologists is necessary.¹⁴For catheterization,

there are various catheters available, with 'Swan neck catheter' showing to be the best one due to least catheterization failure. Catheter should be placed in peritoneum in such position that head of the catheter being in the pelvic space. There is no one superior catheterization technique, however for example Crabtree et al. have reported that laparoscopic catheterization and rectus sheath tunneling plus performing prophylactic omentopexy (fixating omentum to abdominal wall) can reduce complications in a significant way (down to 1% compared with 12% in other techniques).¹⁵Nevertheless, the rate of catheter obstruction depends mostly on agility of the surgery. As an auxiliary method, proper administration of laxatives such as lactulose syrup and senna during the period of catheter use, can lower the adverse results, as constipation and impacted feces can dislocate the catheter. In fact, using laxative even in absence of radiologic features of constipation can optimize the function of catheter.¹⁶Obstruction of catheter flow is mostly due to occlusion of catheter's lumen by fibrin or blood clot, but sometimes kinking is the only cause. In these cases, administrating intra-catheter thrombolytic agents with flushing of microbubbles can effectively maximize the flow.⁵

Macchini et al. found same prevalence and results in a study done in 2006¹⁷; however, in some studies other etiologies such as urinary obstruction and renal dysplasia were the main etiologies leading to ESRD.¹⁸Infectious causes rather than non-infectious or obstructive causes, were the most common reasons for catheter replacement in our study as shown in some other studies before.¹⁹⁻²²In

the study done by Macchini et al. in 2006, non-infectious complications of peritoneal dialysis were 41% of total 78 children who were under routine dialysis between 1986 and 2002,¹⁷ a result close to our 40.3% prevalence of infectious outcomes. Rinaldi reported the rate of 33% for non-infectious complications among 363 children older than 15 years who were on peritoneal dialysis between 1986 and 2000.¹⁹ In contrast, in a study done by Greenberg et al. in Brazil, rate of non-infectious complications (mostly umbilical hernia, catheter obstruction and ultra filtration failure) was 93%. Some points of difference in comparison with other studies were catheterization technique, stage of ESRD and the number of patients.²³ Prior abdominal surgery can lead to catheter dysfunction as shown in the study done by Crabtree et al. as in this study. Aksu et al. reported same results in a study done on 33 patients in 2007.¹⁵ Crabtree et al. have reported laparoscopic catheterization method plus rectus sheath tunneling and prophylactic omentopexy as a proper and safe method of catheterization; as adverse outcomes lowers to 1% compared with 12% in other laparoscopic catheterization procedures.¹⁵ In a study done by Macchini et al. omentectomy while inserting the catheter can reduce further complications. In our 30-case study, 2 of 3 catheter obstructions were seen in patients not having concurrent omentectomy¹⁷.²⁴ There are various catheters available, with 'Swan neck catheter' showing to be the best one due to least catheterization failure. We did not have any control group and we used swan neck catheter for all of our patients. Catheter should be placed in peritoneum in such a position that the head of the catheter remains in the pelvic space. In our study,

catheter survival in patients was 80% in a 12-month period, 62% in a 24-month period and 58% for 36-month and 48-month period. Besides, the survival rate had a positive correlation with child's age, as shown in some other studies.⁴ The mean catheter survival was 6.5, 16(5-68) and 19.5(1-133) months in children under 2 years old, between 2-5 years old and older than 5 years, respectively. The reason could be lower vulnerability of older children to infection in comparison to younger ones or simply their better collaboration with the medical staff. In infants, surgical complications are much higher. As hemodialysis is impossible in this age group, in times of need for emergency dialysis it could merely be done peritoneally. This force major action, leads to higher possibility of adverse outcomes such as leak and hernia.²⁵

In the study done by Phan et al. done on 207 children, who received dialysis between 1994 and 2009, the mortality in a 72-month follow up was 7%, 49% of children needed second surgery for catheter replacement (with the mean catheter life span of 11 months) and 14% of children suffered hernia during the course of dialysis in comparison with our study that surgical complications of PD catheters were seen in one out of every 4 patients during 6 months follow up, the mean of catheter complications was 2.2 ± 1.9 . Peritonitis (40%) and catheter site infections remain the major drawbacks of PD catheter treatment which are seen in one out of every 6 patients during 7 months of catheter insertion. Infection was the most common complication with the prevalence of 1 in every 7.6 patient-month of infection.²⁶ The duration of an PD catheter survival in our study was 80% in

12 months, 62% in 24 months and 58% in 36 to 48 months of follow up. A significant higher rate of catheter survival was observed in children with older age ($P=0.03$), as shown in fig.1. In other studies (Macchini et al. for example with the rate of 61%), infectious complications were the most noticeable.¹⁷ Finally, some of the limitations of our study were small size of samples and being single-centered. Further multi-centered studies warrant a much reliable outcome. For recommendations, due to the high prevalence of infectious complications, taking some preventive measures such as correct use of catheter in wards, considering standard techniques as recommended in surgical technique text books and high competency of surgical team can result in optimal outcomes, less complications and longer catheter survival.

Conclusion

In our study, catheter-related complication rate

was much higher in children of younger age. In the current study, the main cause of PD catheter removal was peritonitis, so prevention of further infections is highly suggested.

Ethical Consideration

This study was approved by Research Institute of Children Health - Shahid Beheshti University of Medical Sciences with code number IR.SBMU.RICH.REC.1399.009

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Conflict of interests

There is no conflict of interest.

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