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Urgent initiation of peritoneal dialysis in children: A fifteen-year experience

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Abstract

Background: Due to the frequency of early mechanical complications many programs avoid peritoneal dialysis when dialysis initiation is urgently needed. We report here our 15-year experience of urgent initiation of peritoneal dialysis using a technique developed at our center allowing successful initiation of dialysis within 24 hours of placement.

Methods: Records from all pediatric peritoneal dialysis catheter placements between years 2000 and 2015 were reviewed for technique, timing of use, and complications. Of 36 catheters placed with intention to use within 24 hours of placement, 3 catheters were excluded from analysis for insufficient available records.

Results: Of these 33 catheter placements, 7 were placed in chronic patients needing dialysis urgently, and 26 were placed in acute renal failure patients. Catheter function was without problem in 21 cases. Early dialysate leaking occurred in 5 patients. Two were treated with surgical revisions and both were successfully restarted on peritoneal dialysis. Three other leaks resolved spontaneously, but hemodialysis was need in 2 patients. Late leaks from tugging occurred in 2. Other complications were seen in 4 patients.

Conclusion: Successful use of peritoneal dialysis catheters within 24 hours of placement is possible for most pediatric patients. Leaks can be dealt with surgically if necessary. Urgent initiation of peritoneal dialysis may be particularly useful when hemodialysis is not readily available, but is also useful in avoiding vascular injury from temporary vascular access placement.

Introduction

Urgent initiation of dialysis is often needed in pediatric patients with both acute and chronic renal failure, including newborns presenting with end-stage renal disease (ESRD). The reasons for the urgency are the need to prevent or treat volume and electrolyte disturbances, as well as the need to safely provide adequate nutrition [1-4]. Prompt onset of dialysis has been shown beneficial, especially in the pediatric cardiac surgery patient [5,6]. Peritoneal dialysis is sometimes avoided in pediatric patients needing urgent dialysis therapy due to concerns of frequent complications [7-10]. In children over six years of age with acute renal failure, peritoneal dialysis is much less likely to be used as compared to other dialytic modalities [11]. The risk of early dialysate leakage is often cited as a reason to delay use of a peritoneal dialysis catheter for the first 14 days after placement [7,10,12].

We have developed a successful technique for catheter placement which allows for urgent initiation of peritoneal dialysis in children within 24 hours of catheter placement. This technique prevents omental encasement of the catheter, is associated with a low leak rate, and has a low modality failure rate. Our principal objective is to demonstrate that peritoneal dialysis can be instituted rapidly and successfully with minimal complications and low risk for modality failure in pediatric patients. Our secondary objective is to demonstrate that surgical repair of dialysate leaks may be considered as an alternative to a non-surgical waiting approach, avoiding the risks of vascular access placement.

Subjects and methods

All charts were reviewed for all peritoneal dialysis catheters placed at a single center in pediatric patients over a fifteen-year period beginning in the year 2000. Charts were reviewed for: Cause for renal failure including whether the dialysis was for acute kidney injury (AKI), or end-stage renal disease (ESRD) presenting with urgent need for dialysis. All complications of dialysis were recorded, whether or not they were considered to be catheter related. Complications were deemed "early" if they occurred within 14 days of catheter placement, or "late" if they occurred between 14 and 90 days. Replaced or revised catheters were not counted as additional catheter placements, but descriptions and complications of those additional procedures were included in the analysis. Variations from the described technique were recorded, as well as time interval between placement and initiation of dialysis, all interventions needed including surgical revisions, need for temporary hemodialysis, and all dialytic modality changes. Catheter placements were only included if there was intention to use the catheter within 24 hours of placement, and records were sufficient to determine timing and complications of catheter placement.

The surgical technique employed involves several key steps. Double-cuffed, Tenckhoff catheters with downward or lateral subcutaneous tunnels were placed exclusively, as per International Society of Pediatric Dialysis (ISPD) consensus guidelines for chronic

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dialysis catheters [13]. To begin, a single small incision is made in the midline, positioning vertically to allow the "curl" of the catheter to be within the pelvis and avoiding the beltline for the exit site. This incision site is used as a port for inspection of the peritoneum with the laparoscope, access site for delivering and trimming the omentum, and insertion site for the intraperitoneal portion of the catheter. There are no separate laparoscopic ports placed. After the omentectomy is accomplished, the subcutaneous tunnel is created using a 10 French trocar chest tube. The catheter is pulled through this tunnel – usually directed to the left when future renal transplant is anticipated. The deep portion of the catheter is inserted through the single incision into the pelvis with the curl temporarily straightened during placement using a metal or plastic stylet. The laparoscope is inserted one last time to verify correct catheter placement. The peritoneum is closed with a purse-string suture around the catheter just deep to the distal cuff, which places the distal cuff between the peritoneum and the fascia. The fascia is closed with figure-of-eight stitches. Before completing the closure, saline or dialysate is infused into the peritoneum through the catheter to check for dialysate leakage and also for catheter pinching. Finally, there is meticulous closure of subcutaneous layers. While the skin is closed, one more full exchange of fluid is done to insure proper flow. The incision closure is completed with a tissue adhesive. A sterile dressing covers the site and the catheter is secured to the skin.

Dialysis exchanges were begun the morning following surgery with peritoneal fill volumes of 10-20 ml/kg. Dialysis exchanges were performed either hourly or every two hours. Peritoneal fill volumes were increased over the next seven days to a maximum of 30 ml/kg.

Results

Forty-six peritoneal dialysis catheters placed in pediatric patients in a single center between the years 2000 and 2015. 10 catheter placements in ESRD patients were excluded for lack of intention to start dialysis within 24 hours of placement. We excluded three cases where chart records were insufficient, leaving 33 catheter placements in (33 patients) for analysis. Dialysis was begun within 24 hours in all cases.

These patients ranged in age from 4 days to 10 years of age. Details of their age and gender are shown in Table 1. Seven patients were initiating dialysis for ESRD but presented with urgent need for dialysis. The remaining 26 patients needed urgent dialysis for acute renal failure. For all but two patients, the cause for acute renal failure was hemolytic-uremic syndrome (HUS).

Peritoneal dialysis catheters were placed by five different surgeons, although 73% of the cases and 100% of the revisions were done by the surgeon who originated the above-mentioned surgical technique. The procedure was performed as a laparoscopic-assist procedure in all. Deviations from the above-detailed procedure occurred in five cases. In four of these five cases, the deep cuff incision was placed in the right paramedian location as opposed to the midline. Of these four cases, extra port placements were performed in two patients in order to facilitate omentectomy. The deep cuff was placed 'half within the peritoneal cavity in two and in subcutaneous tissue above the rectus fascia in the other two. One final procedural deviation occurred when an additional port was used in a premature infant to assist in correct placement of the catheter. Complications occurred with all deviations and are detailed below. For those procedures performed without deviation there were only two early dialysate leaks, one episode of fungal peritonitis episode, and a colonic perforation in a child with hemolytic-uremic syndrome (HUS). The latter two complications were not considered to be related to the placement procedure.

Dialysate leaking complications are shown in Table 2. Early leaking of dialysate was the most common complication, occurring in five cases (15%), and always presenting within the first three days following placement. Surgical revision was performed in two of these cases with dialysis restarted the same day without further leakage or other complications noted. In the cases of the other three dialysate leaks, it was elected to interrupt peritoneal dialysis to provide time for the leak to seal on it's own. In two these patients, hemodialysis was necessary for fluid and solute control for a brief period. Peritoneal Dialysis was ultimately restarted in all three patients without further leakage. Three of the above mentioned five dialysate leaks occurred in small infants, two of which were premature and in the first week of life. Leaks occurred in all cases when extra port sites were used – one into the tissue planes near the port, and two out the exit site. Two late leaks occurred at 30 and 35 days' post placement and were associated with inadvertent tugging on the external portion of the catheter. There was brief leaking from the exit site in one case, and an internal tissue plane leak in the other. Both resolved with reduced fill volumes over the next three days.

Other complications of the dialysis treatment are shown in Table 3. Only the catheter migration was considered to be directly due to catheter placement. Only the colonic perforation and fungal peritonitis cases resulted in modality failure, with both patients switching to hemodialysis for the duration of dialysis. Twenty-five (96%) of the children with ARF survived to hospital discharge and 24 (92%) recovered renal function.

Discussion

We have described a cohort of infants and children with renal failure treated with urgent initiation of peritoneal dialysis using a minimally invasive surgical technique which has allowed successful dialysis therapy in the majority of our cases. In the majority of cases (67%), dialysis procedures were problem free for the entire duration of dialysis. Hemodialysis was not required after any catheter revisions

Table 1. Demographics of Peritoneal Catheter Placements.

Patient demographics n=33	n (%)
Premature Infants	3 (09%)
Infants	2 (06%)
Toddlers	10 (30%)
Preschoolers	11 (33%)
School-aged	7 (21%)
Male	12 (36%)
Female	21 (64%)

Table 2. Dialysate Leaking Complications of Peritoneal Catheter Placements.

Time period	Dialysate	Revised or replaced	Spontaneously sealed	Hemodialysis needed
	leaks			
Early	5	2	3	2
Late	2	0	2	0
Total	7	2	5	2

Table 3. Other Complications of Peritoneal Catheter Placements.

	Complications	Revised	Removed	Hemodialysis needed
Fungal peritonitis	1	0	1	1
Bacterial peritonitis	1a	0	0	0
Bowel perforation	1	1	1	1
Catheter migration	1	1	0	0

[a] Catheter was removed and replaced at a subsequent time.

or replacements. Very few modality failures occurred (6%), and of the two failures, neither were considered directly related to the catheter placement.

There are very few reports describing complication of peritoneal dialysis catheters placed and used urgently in children with acute or chronic renal failure [14-16]. Our results are similar to a 2001 report from a single North American center using similar fill volumes [14] They reported a 25% total complication rate and a 9% modality failure in 63 pediatric patients. Another study in 2013 from Iran using similar initial fill volumes showed a 62% complication rate, although only 27% of complications were non-infectious [15]. An older report from 1991, using fill volumes increased to 40 ml/kg by the 4th day reported much higher complication rates which were well over 50% of cases, including catheter malfunctions, infections, and 53% with hernias [16].

Early catheter dialysate leaking was our most frequent complication at 15% of cases. This compares to reported rates from the studies above ranging 5% to 28% [14-16]. The highest leakage rates were associated with the center using the highest fill volumes. In our experience, most (3 of 5 cases) of the early leakage occurred in small or premature infants. Others have noted high rates of leakage in very small infants which has been suggested to be due to a lack of size-specific catheters [17]. Higher rates of leakage (and other catheter malfunction) was also noted to be higher with temporary percutaneous bedside-placed catheters as opposed to surgically-placed catheters [14].

Current recommendations for treating dialysate leakage include a reduction of the fill volume, temporary cessation of peritoneal dialysis, or surgical repair [7]. In our experience, all surgically repaired catheters were able to be used the same day as surgical correction. We suspect that prevention of leakage is very dependent on both fill volume and surgical technique. Use of fibrin glue placed into the tunnel close to the superficial cuff has also been successfully employed by others, allowing patients to restart peritoneal dialysis quickly [18,19].

No complications related to the omentum occurred in any case, demonstrating the effectiveness of the omentectomy technique used. The midline incision would be expected to provide better access to the entire omentum than only a right or left-sided access. Lack of an adequate omentectomy has been shown to be associated with catheter obstruction [20]. Omentectomy was not done routinely in any of the above-mentioned reports, and likely resulted in higher rates of catheter malfunction due to omental encasement of the catheter [14-16].

Extravasation of dialysate into the abdominal wall was also uncommon in our cohort, perhaps because our surgical technique limited laparoscopic port sites to the single incision where the deep cuff would be placed, and that site was closed in layers. All of our catheter placements with more than one laparoscopic port placement had a complication associated. We suggest that that avoidance of extra port placements may reduce the frequency of internal leaks of dialysate into tissue planes at the port entry site when rapid initiation of dialysis is planned

The optimal placement of the deep cuff in relationship to the peritoneal membrane has not been established. In our experience, placing the deep cuff midline, and between the peritoneum and fascia was the most successful technique. Placement of the cuff within the subcutaneous tissue was associated with leakage. There remains a debate as to whether the deep cuff should be within the midline, or within the rectus muscle [11]. The Italian registry of pediatric chronic peritoneal dialysis showed higher leakage rate of catheters placed with entry in the midline, although the results were not statistically significant [13].

The major strength of this study is the large number of catheters placed with plans for urgent start of dialysis in children. Weaknesses of the study include the retrospective nature, as well as insufficient numbers for statistical analysis of technique deviations.

Conclusion

Urgent initiation of peritoneal dialysis can be accomplished with a relatively low complication rate and very low rate of modality failure. Universal omentectomy performed at the time of catheter placement should reduce catheter obstruction. When leaks of dialysate occur, surgical revision is a treatment option which may allow the patient to recommence dialysis quickly, avoiding the risks related to delays in dialysis provision, and avoiding risks related to hemodialysis. Programs developing the ability to initiate peritoneal dialysis urgently may improve outcome and reduce short and long-term vascular complications, especially when resources are limited, or when used in the most vulnerable small infants.

Conflict of interest disclosure

We have read and understood the policy on disclosing conflicts of interest and declare that we have none.

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