Original Article

Indications and complications of peritoneal dialysis in children with acute renal failure, a single center experience

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Abstract:

Background: Peritoneal dialysis (PD) is the preferred and convenient treatment modality for acute renal failure (ARF) in children and hemodynamically unstable patients, because of its inherent advantages: technique can be initiated simply and quickly, no highly trained personnel nor expensive and complex apparatus are required and systemic anticoagulation is not needed.

Objectives: is to highlight the role of peritoneal dialysis in management of children with acute renal failure and to determined its complications.

Patients and methods: A retrospective study was carried out from 20th April 2012 till1st May 2014 ,on children with acute renal failure admitted to nephrology unit in Child Welfare Teaching Hospital and peritoneal dialysis was done for them in the acute intermittent peritoneal dialysis ward which was established since 2012 . Age ranged from one day up to fifteen years .Indications, complications of the procedure and outcome of recovery were recorded.

Results: Fifty nine children with acute renal failure were enrolled in the present study 23(39%) female and 36(61%) male, their age ranged from (8 days-15 years). congenital malformations of renal system 13 (22%), hemolytic uremic syndrome 10(16.9%), sepsis 7(11.9%) were the predominant causes of acute renal failure. Complications of dialysis were significantly low among studied patients 18.6%($p<0.001$).The main dialysis related complication was catheter malfunction(45%). The incidence of peritonitis 1(9%)($P=0.01$). Recovery of renal function after peritoneal dialysis found in 42 patients Survival rate among these patients was 97.6% ($p<0.001$) .Overall mortality was 22%. The most common cause of death was septicemia in (57%) of patients.

Conclusions: Because of its simplicity and feasibility, acute PD is still an appropriate treatment choice for children with ARF

Key words: acute renal failure, children, peritoneal dialysis.

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Introduction:

The choice of modalities for renal replacement therapy (RRT) in pediatric acute kidney injury (AKI) is broad and includes peritoneal dialysis (PD), intermittent hemodialysis (HD), and continuous RRT (1). Major drawbacks of HD and RRT therapies, however, are their technology dependence and increased financial cost. Pediatric application of continuous (RRT)therapies is even more technology dependent than in adults because of the need for specialized blood pumps, hemofilters, and blood lines of varying sizes in order to accommodate large as well as small patients. In addition, specialized nursing personnel experienced in caring for such patients are mandatory in order to safely deliver this complex therapy (1,2).

Acute peritoneal dialysis is a continuous dialysis therapy which requires much less technical expertise, expense, and equipment compared to Intermittent hemodialysis (IHD)and continuous renal replacement therapy(CRRT). PD catheters can be placed quickly and easily. In centers with expertise, a non-tunneled PD catheter can be placed percutaneously at the bedside (3). in the 1970s, acute peritoneal dialysis (PD) was widely accepted for acute kidney injury (AKI) treatment, but its practice declined in favor of hemodialysis [4-7]. Recently, interest in using PD to manage AKI patients has been increasing. [6,7]. The studies performed by Gabriel et al. [7] showed that, with careful thought and planning, critically ill patients can be successfully treated by PD .

Aim of study: In the present study, we report a single-center experience with acute PD. To highlight its role in management of children with ARF, and to determine its complications.

Patients and methods:

This retrospective analysis includes fifty nine (59)children with ARF requiring acute PD who were admitted to Child Welfare Teaching Hospital between 20th April 2012 and 1st of May 2014.

Acute renal failure was defined according to the modified pediatric RIFLE (risk, injury, failure, loss, end-stage renal disease) criteria (8).

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A detailed history was recorded, and a clinical examination including blood pressure measurement was performed for every patient.

A complete blood count, blood urea, serum creatinine, electrolytes, calcium, phosphate, arterial blood gases, were obtained for every patient. Urinalysis and cultures were performed in the patients who passed urine.

Blood culture, and renal ultrasonography were performed as clinically indicated.

Patients were managed using standard hospital protocol for ARF (including management of fluid and electrolyte disturbances, anemia, and hypertension), and the underlying condition was appropriately addressed.

In breastfed infants, breastfeeding was continued. Older infants and children were put on salt restriction. In unconscious patients, enteral feeding was given by nasogastric tube until consciousness was regained and spontaneous oral food intake could be resumed.

Peritoneal dialysis was performed in the peritoneal dialysis unit by placing a commercially available disposable pediatric-size semi-rigid PD catheter. Maintaining strict aseptic conditions, the catheter was placed percutaneously with the help of a trocar under local anesthesia and connected to the PD set with bags containing PD fluid. We used 10 - 20mL/kg of PD fluid for the initial 1 - 2 cycles to check for smooth filling and drainage of fluid without leakage. Thereafter, the fill volume was increased to 20 – 35 mL/kg .

A deep subcutaneous purse-string suture was usually applied around the PD catheter at the site of entry into the peritoneal cavity to minimize the risk of fluid leakage. Leaking catheters were exchanged immediately.

Total duration of each cycle was about 60-90 minutes (24 cycles daily) for 72 hours by a resident physician, after which a break of 12 - 24 hours was used to observe for the recovery of renal function. Dialysis was resumed if oliguria or anuria and azotemia persisted.

The commercial PD solution used (solution A) contained dextrose 1.7%, Na+ 130 mmol/L, Ca++ 1.5 mmol/L, Mg++ 0.75 mmol/L, Cl- 100 mmol/L, and HCO3- 35 mmol/L.

In patients presenting with features of fluid overload, PD fluid containing 2.5% dextrose (solution B) was used initially for several exchanges and then switched over to 1.7% once euvolemia was attained .Antibiotics added to PD fluid (vancomycin 0.5g once, ceftriaxone 1g in each pint) used to avoid development of peritonitis.

Peritonitis was diagnosed based on the presence of abdominal pain, diffuse tenderness, cloudy appearance of effluent, and increased effluent cell count (polymorphonuclear leucocytes) with or without culture positivity.(1)

Clinical monitoring during PD included heart rate, blood pressure, oxygen saturation, and continuous electrocardiography on a dynamic monitor. Urine output and biochemical parameters (blood urea, serum creatinine, electrolytes, and arterial blood gases) were monitored.

Statistical analysis

Data of all patients were entered into a computerized software, and a database was made, then transferred into a statistical package for social sciences (SPSS) software for windows, version 18, US. Descriptive statistics were presented as mean ± standard deviation for continuous variables, and as frequencies (number) and percentages for categorical variables. Students' t test was used to compare means, and chi square was used to compare frequencies and percentage in between any two groups. Level of significance of ≤ 0.05 was considered as significant.

Results:

The study included 59 patients with acute renal failure their age ranged (1month - 14 years) mean age was 3.1±3 years,47 (79.6%) patients age was ≤ 5years ,six patients 10.2 % were between 6-10 years and six patients were above 10 years , p value was significant (<0.001). thirty six (61%) patients were Male and 23(39%) were female .

The main causes of renal failure for studied patients were 13(22%)patients had congenital malformation of renal system included (ten patients bilateral vesicoureteric reflex, one patient neurogenic bladder and one patient had hypopalstic kidneys),ten patients(16.9%) had HUS, seven (11.9%)patients had sepsis, five patients(8.5%) had metabolic diseases in ,seven patients (8.5%) had nephrotic syndrome (NS) ,acute on chronic renal failure (6.8%), dehydration (6.8%), poisoning (6.8%),three patients (5.1%) had obstructive uropathy (posterior urethral valve) .SLE nephropathy (3.4%), Glomerulonephritis (GN) (1.7%) and polycystic kidney (1.7%), table1.

Table 1: Causes of renal failure for studied patients

Variable	No.	%	χ^2	P
Dehydration	4	6.8		
Sepsis	7	11.9		
Hemolytic uremic syndrome	10	16.9		
Glomerulonephritis	1	1.7		
Nephrotic syndrome	5	8.5		
Polycystic kidney	1	1.7		
Poisoning	4	6.8		
metabolic disease	5	8.5	28.6	0.003
**Congenital malformation of renal system	13	22.0		
SLE nephropathy	2	3.4		
***Obstructive uropathy	3	5.1		
Acute on chronic renal failure	4	6.8		
Total	59	100.0		

*patient may have more than one indication
** Vesicoureteric reflux, neurogenic bladder, hypopalstic kidneys
***posterior urethral valve

Indications for dialysis among studied patients were: refractory acidosis 12(15%), hypernatremia 1(1%), hyperkalemia 1(1%), anuria 10(12%), uremic encephalopathy 10(12%), uncontrolled volume overload 9(11%), hypertensive encephalopathy 6 (7%) and significantly rapidly increasing renal indices32(40%), table 2.

Table 2: Frequncy of Indications of peritoneal dialysis for studied patients.

Variable	No.	%	χ^2	P
Refractory acidosis	12	15.0		
Hypernatremia	1	1.0		
Hyperkalemia	1	1.0		
Anuria	10	12.0		
Uremic encephalopathy	10	12.0	18.7	0.001
Uncontrolled volume overload	9	11.0		
Hypertensive encephalopathy	6	7.0		
Rapidly increasing blood urea	32	40.0		
Total	81	100.0		

Complications of peritoneal dialysis were significantly low among studied patients (18.6%) ,($p<0.001$) , the types of complications were exit site bleeding (27%), pleural effusion (9%), peritonitis (9%), catheter malfunction (45%) and trauma of internal organs (9%), table 3.

Table 3:Peritoneal dialysis complications of studied patients.

Variable	No.	%	χ^2	P
Complications				
No	48	81.4	23.2	<0.001
Yes	11	18.6		
Types of complications				
Exit site bleeding	3	27%		
Pleural effusion	1	9%		
Peritonitis	1	9%	8.7*	0.01
Catheter malfunction	5	45%		
Trauma of internal organs	1	9%		

*Fishers exact test.

Thirteen (22%) patients died in the study ,it was statistically significant ($p<0.001$).

There was no significant difference in age groups between dead and survived patients ($p=0.3$).table (4)

Additionally, no significant difference in gender was observed between dead and survived patients ($p=0.5$).Table (4)

There was statistical significant association between recovery of renal function and outcome ($p<0.001$). About two-thirds of patients with no recovery of renal function died. table (5)

No significant association was observed between causes of renal failure and death ($p=0.7$) as shown in table 5.

Table 4: Correlation between demographic characteristics and outcome of the study group after PD

Variable	Death		Survival		χ^2	P
	No.	%	No.	%		
Age groups (years)						
≤ 5	12	25.5	35	74.5	2.1	0.3
6-10	0	-	6	100.0		
> 10	1	16.7	5	83.3		
Gender						
Male	9	25.0	27	75.0	0.4	0.5
Female	4	17.4	19	82.6		

Table 5: Correlation between recovery of renal function and causes of acute renal failure with outcome of the study group after PD

Variable	Death		Survival		χ^2	P
	No.	%	No.	%		
Recovery of renal function						
Yes	1	2.4	41	97.6	32.7*	<0.001
No	12	70.6	5	29.4		
Causes of ARF						
Dehydration	1	25.0	3	75.0	7.8*	0.7
Sepsis	4	57.1	3	42.9		
Hemolytic uremic syndrome	2	20.0	8	80.0		
Glomerulonephritis	0	-	1	100.0		
Nephrotic syndrome	1	20.0	4	80.0		
Polycystic kidney	0	-	1	100.0		
Poisoning	0	-	4	100.0		
metabolic disease	1	20.0	4	80.0		
Congenital malformation of renal system	3	23.1	10	76.9		
SLE nephropathy	0	-	2	100.0		
Obstructive uropathy	1	33.3	2	66.7		
Acute on chronic renal failure	0	-	4	100.0		

*Fishers exact test.

Discussion:

Acute peritoneal dialysis provides the nephrologist with a nonvascular alternative for dialysis comparable to hemodialysis or continuous renal replacement therapy (CRRT). It is superior in the management of pediatrics acute renal failure, as well as electrolyte, or volume problems in critically ill patients.(9)

Mean age of patients was 3.1+3 years and the majority of the patients were below 5 years of age, this is in consistent with study done in Pakistan.(10)

Male dominancy in this study was similar to that reported by other study(1)

The predominant causes of pediatric ARF vary in different regions of the world. (10).Similar results found in the Indian study(11) in which they found that hemolytic uremic syndrome, septicemia, and acute tubular necrosis were the predominant causes .Other causes of ARF such as post-cardiac surgery ARF, chemotherapy, and organ and bone marrow transplant have become more prevalent in tertiary care units in developed

countries in recent years (11,12).

The data in the treatment of pediatric AKI are clearly limited. the majority of reports are retrospective, small,non-randomized, many of these studies inherently reflect the practice standards of the institution. According to the type of institution reporting results Rapidly increasing blood urea was most common indication (40%)for PD in this study as shown in table (2)compared with other study in Nigeria where the predominant indication for PD was uremic symptoms with seizures.(13) Anurea was an indication for dialysis in 12% in this study ,while in the study done in san Diego, Anurea was the most common cause for Peritoneal dialysis (40%) for ARF in children. (14)

One patient (20 days old neonate) had acute renal failure secondary to severe hypernatremic dehydration (serum sodium was 160 Meq/l) and unresponsive to medical management ,he recovered his renal function after PD. and this is in consistent with other study showing that PD is safe an successful in management of hypernatremic dehydration not responding to medical therapy.(15) Six patients (7%) had a generalized neurologic syndrome consistent with hypertensive encephalopathy, characterized by altered mental function with or without generalized convulsions. In these patients, neurologic examination was normal after lowering of blood pressure, while renal function remained unchanged. significant recovery of renal function in these patients after peritoneal dialysis. These results confirm previous reports of recovery of renal function in patients pre senting with acute renal failure and malignant hypertension. (16). The main dialysis related complication found in this study was catheter malfunction(45%) (table4) caused by leakage of peritoneal fluid or obstruction causing failure of dialysate to drain. This obstruction was thought to be from omentum and fibrin clots. The same result obtained from the Nigerian study (44.4%) (17)

The frequency of peritonitis in children undergoing acute peritoneal dialysis (APD) is reported to be up to 12%.(9)

We used disposable catheters under aseptic conditions with standardized monitoring of vital functions and biochemical parameters for our patients and in this study the frequency of peritonitis was significantly low up to 9%. (P=0.01)(table 3), Compared with other Iraqi study, showed the occurrence of peritonitis in PD pediatric cases as (44%). (18) Peritonitis in this study most likely reflected the septic disease process rather than a complication of PD, even in the patient who developed the complication during treatment, because strict aseptic measures were taken during catheter insertion. The routine use of antibiotics added to PD fluid (vancomycin 0.5g once, ceftriaxone 1g in each pint) used to avoid development of peritonitis,may have contributed to low incidence of peritonitis in this study. However, the small number of dialysed patients in this study makes it difficult to draw a conclusive report on the actual incidence of dialysis related complications.

The mortality rate in children with ARF is highly variable and considered to depend largely on the nature of the underlying disease process rather than on renal failure itself.

The overall mortality in this study was similar to that reported in other studies from Nigerian, Indian and Singaporean (17,1,19)..

Children with ARF caused by a renal-limited condition such as post-infectious glomerulonephritis reportedly have a very low mortality rate (<1%), while mortality is usually very high (up to 90%) in patients with ARF related to multiorgan failure (5) ..This is in consistent with our study results table(5).

The presence of septicemia conferred a great risk of death in this study (57%). That finding with previous experiences of pediatric ARF in developing countries 20,21) Septicemia leads to liberation of various nephrotoxins and may cause vasodilation and relative hypovolemia, thereby aggravating renal failure. The septicemic process also affects other organs, resulting in multiorgan dysfunction, with a detrimental effect on overall prognosis. Survival rate among these patients was statically significant indicating the significant role of peritoneal dialysis in saving life in these patients .Depending on the facilities and expertise available, PD, intermittent hemodialysis, and CRRT are all currently used for pediatric ARF (22)

The CRRT and hemodialysis technologies require vascular access, equipment, technical expertise, and financial resources, all of which largely preclude their use because of non-availability at most centers in Iraq, including ours. Hence, because of its simplicity and affordability, especially where extracorporeal techniques are not available, PD is clearly useful in reducing the mortality attributable to ARF in developing countries.

Conclusion:

Peritoneal dialysis remains an effective therapy that is easily and simply instituted, especially for infants and children with ARF, with significant recovery of renal function and good survival rate .

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