RESEARCH PAPER

Acute Peritoneal Dialysis in Premature Infants

MELIHA AKSOY OKAN[1], SEVILAY TOPÇUOGLU[1], N NILGUN KARADAG[1], ELIF OZALKAYA[1], HANDE OZGUN KARATEPE[1], GONCA VARDAR[1], AYSENUR CELAYIR[2] AND GUNER KARATEKIN[1]

From [1]Departments of Neonatology and [2]Paediatric Surgery, Zeynep Kamil Maternity and Children's Training and Research Hospital, University of Health Sciences, Istanbul, Turkey.

Correspondence to: Dr Meliha Aksoy Okan, Department of Neonatology, Zeynep Kamil Maternity and Children's Training and Research Hospital, University of Health Sciences, Istanbul, Turkey. melihaaksoy@hotmail.com.
Received: *January 01, 2019;*
Initial review: *June 06, 2019;*
Accepted: *January 28, 2020.*

Objectives: This study aimed to investigate the underlying causes and outcomes of less than 1500 g birth weight infants who underwent acute peritoneal dialysis (PD). **Methods:** Case records of infants with birthweight less than 1500 g from January 2015 to June 2018 were reviewed. **Results:** The median (range) birth weight and gestational age of the patients were 720 g (555-1055) and 26 weeks (23-27.5), respectively. Underlying factors for the development of acute kidney injury (AKI) were patent ductus arteriosus (PDA) (15 patients), necrotizing enterocolitis (NEC) (10 patients), sepsis (7 patients), asphyxia (2 patients) and hydrops fetalis (2 patients). Multifunctional 10 F flexible catheter was used for the procedure. Median PD onset time was 7 days (4.5-13.5) and median PD duration was 3 days (1.5-3.5). Overall mortality rate was 81 % (*n*=17). **Conclusions:** Despite high overall mortality, PD is technically feasible in very low birthweight (VLBW) and extremely low birthweight (ELBW) neonates using a multifunctional catheter.

Keywords: *Acute kidney injury, Low birth weight infant, Peritoneal dialysis.*

Peritoneal dialysis (PD), hemodialysis, continuous hemodialysis, hemofiltration-hemodiafiltration or slow continuous ultrafiltration are therapeautic options for renal replacement therapy (RRT) for acute kidney injury (AKI) [1]. PD is the preferred modality than hemodialysis because it is more physiological, results in less pro-inflammatory effects than hemodialysis, simplicity of the method, minimal requirement of equipment and avoidance of the morbidity of vascular access [2-4]. However, the morbidity and mortality rates of PD in premature infants may be high because of concomitant systemic problems that contribute to the development of AKI. There are limited studies demonstrating the experience of PD in very low birthweight (VLBW) and extremely low birthweight (ELBW) neonates. We report experience of PD in preterm neonates with AKI and risk factors of AKI, complications of PD and causes of deaths.

METHODS

This retrospective study was conducted in the Department of Neonatology, Zeynep Kamil Maternity and Children's Training and Research Hospital, University of Health Sciences, Istanbul. Data on VLBW and ELBW premature neonates who underwent PD for AKI between January 2015 and June 2018 were collected. Medical information for demographic data, laboratory parameters, post-treatment recovery and mortality rates were extracted.

Accompanying Editorial: Pages 399-400.

PD was indicated for AKI (urine output of <0.7 mL/kg/h for 24 h or anuric for 12 h) [5] and failure of conservative treatment (furosemide or water restriction in cases without hypovolemia) or signs of uremia (impaired cardiac and respiratory function or seizures), refractory hyperkalemia, and metabolic acidosis or fluid overload. PD catheters were inserted by a pediatric surgeon under sterile conditions with local anesthesia at the bedside. The multifunctional catheter is polyethylene, disposable, non-traumatic, rounded with distal two-hole, and can also be used for aspiration or discharging (10 F, Bicakcilar, Turkey). A single-headed multifunctional flexible catheter was placed percutaneously in the left lower quadrant following a 0.5-1 cm horizontal incision below the umbilicus in the supine position. Approximately 4 h after the catheter placement, manual PD administration was started at 10 mL/kg/h and gradually increased up to 20-30 mL/kg/h with the standard dialysate solutions with glucose concentrations of 1.36%, 2.27%, or 3.86% (Dianeal,

WHAT THIS STUDY ADDS?

- Peritoneal dialysis is technically feasible in premature neonates weighing below 1500g using a multifunctional catheter.

Baxter Healthcare, Deerfield, USA). The catheter was connected to the peritoneal dialysate fluid and drain bags. The one hour-PD cycle comprised of three periods: filling (10 minutes), dwelling (30 minutes), and draining (20 minutes). Heparin and antibiotics were added to dialysis fluid at a dose of 40 U/L with 125 mg ampicillin and 125 mg cefazoline per liter.

Statistical analysis was performed using SPSS 16 for Windows. Continuous data was expressed as median and interquartile range (IQR). Categorical data was expressed as proportions and compared using Chi-square test. Nonnormally distributed numerical and ordinal variables were compared with the Mann Whitney U test. Student *t*-test was performed to compare parametric variables. Paired *t*-test was used to compare paired samples. A *P* value of less than 0.05 was considered statistically significant.

RESULTS

Twenty one (2.8%) (11 males) out of 714 neonates (birth weight <1500 g) required PD during the study period. The median (IQR) birth weight and gestational age of the neonates were 720 g (555,1055) and 26 weeks (23, 27.5), respectively. Fifteen (71.4%) neonates were ELBW and 12 (57%) were delivered by cesarean section. Underlying factors for the development of AKI were patent ductus arteriosus (PDA) (*n*=15), necrotizing enterocolitis (NEC) (*n*=10), sepsis (*n*=7), asphyxia (*n*=2) and hydrops fetalis (*n*=2). Median (IQR) PD onset time was 7 days, (4.5,13.5) and median (IQR) PD duration was 3 days (1.5, 3.5). Demographical data and biochemical parameters before and after PD are depicted in ***Web Table* I**. Significant difference was observed in pH levels (*P*=0.007), unlike other parameters. There was no improvement with PD for oliguria and hyperkalemia in ten neonates, serum urea levels in 15 neonates and acidosis in eight neonates.

Dialysis related complications were observed in nine patients (42.8%) neonates. Leakage developed in 6 (28.5%) neonates, but did not hamper working and catheter revision was performed in 3 (14.2%) neonates with catheter obstruction. Intestinal perforation or bladder injury was not observed. Color change was observed in the peritoneal fluid in 5 (23.8%) neonates with a history of perforated NEC but cultures were sterile. The mortality rate was 81% (*n*=17).

DISCUSSION

The present study reports etiology of AKI and experience with PD in ELBW and VLBW neonates. The retrospective nature and the small number of cases are the main limitations of this study. The main causes of AKI in VLBW and ELBW infants are sepsis, asphyxia, respiratory distress syndrome (RDS), PDA and NEC [6-9]. PD is the most preferred RRT strategy for AKI treatment in preterm infants in our clinic. Slow and controlled fluid removal provided by PD makes fluid elimination safer without hemodynamic instability [10]. However, inappropriate placement, occlusion or leakage of the catheter, peritonitis, and perforation are frequent factors that restrict its use [11]. Mortality with catheter related complications significantly decreased with the use of Tenckhoff catheters [12]. However, the limited availability of appropriately sized PD catheters for VLBW and ELBW infants is a common challenge. Yu, *et al*. [6] performed PD using vascular catheter in babies with birth weight <1000 g. Bed-side catheter insertion and ease of use of a multifunctional flexible 10F catheter makes it an accessible and inexpensive choice. Problems such as insufficient flow and high risk of leakage around the catheter may be seen. Leakage rates may vary from 5.8 – 29% [7,8,13], similar to our results.

The morbidity and mortality rates with PD are higher in neonates with multisystem problems [14], reported earlier 59.3-81.3% [7,8,15,16]. Mortality rate in the present study was higher, probably as the median gestational age and birth weight of were lower. Tetta, *et al*. [17] reported high (95%) mortality rate in premature babies with multiorgan failure and sepsis, which could be related to the underlying causes, rather than complications of PD.

To conclude, PD is technically feasible in VLBW and ELBW neonates using a flexible 10F catheter. Clinical and biochemical improvement in AKI is governed by uderlying cause of AKI.

Contributors: MAO, ST, NNK, EO, HOK, GV, AC, GK: conception and design of the work, acquisition, analysis, and interpretation of data for the work; drafting the work or revising it critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding: None; *Competing interest*: None stated.

REFERENCES

1. Walters S, Porter C, Brophy PD. Dialysis and pediatric acute kidney injury: Choice of renal support modality. Pediatr Nephrol. 2009;24:37-48.
2. Haubitz M, Brunkhorst R, Wrenger E, Froese P, Schulze M, Koch KM. Chronic induction of C-reactive protein by hemodialysis, but not by peritoneal dialysis therapy. Perit Dial Int. 1996;16:158-62.
3. Genc G, Bicakci U, Gunaydin M, Tander B, Aygun C, Ozkaya O, *et al*. Temporary peritoneal dialysis in newborns and children: A single-center experience over five years. Ren Fail. 2012;34:1058-61.
4. Sizun J, Giroux JD, Rubio S, Guillois B, Alix D, De Parscau. Peritoneal dialysis in the very low-birth-weight neonate (less than 1000 g). Acta Paediatr. 1993;82:488-9.
5. Ricci Z, Ronco C. Neonatal RIFLE. Nephrol Dial Transplant. 2013; 28:2211-4.
6. Yu JE, Park MS, Pai KS. Acute peritoneal dialysis in very low birth weight neonates using a vascular catheter. Pediatr Nephrol. 2010;25:367-71.
7. Ustyol L, Peker E, Demir N, Agengin K, Tuncer O. The use of acute peritoneal dialysis in critically ill newborns. Med Sci Monit. 2016; 22:1421-6.
8. Alparslan C, Yavascan O, Bal A, Kanik A, Kose E, Demir BK, *et al*. The performance of acute peritoneal dialysis treatment in neonatal period. Ren Fail. 2012;34:1015-20.
9. Selewski DT, Charlton JR, Jetton JG, Guillet R, Mhanna MJ, Askenazi DJ, Kent AL. Neonatal Acute Kidney Injury. Pediatrics. 2015 Aug;136(2):e463-73. doi: 10.1542/peds.2014-3819.
10. Burdmann EA, Chakravarthi R. Peritoneal dialysis in acute kidney injury: Lessons learned and applied. Semin Dial. 2011;24:149-56.
11. Vasudevan A, Phadke K, Yap HK. Peritoneal dialysis for the management of pediatric patients with acute kidney injury. Pediatr Nephrol. 2017;32:1145-56.
12. Chadha V, Warady BA, Blowey DL, Simckes AM, Alon US. Tenckhoff catheters prove superior to cook catheters in pediatric acute peritoneal dialysis. Am J Kidney Dis. 2000;35:1111-6.
13. Hakan N, Aydin M, Zenciroglu A, Aydog O, Erdogan D, Saygili Karagol B, *et al*. Acute peritoneal dialysis in the newborn period: a 7-year single-center experience at tertiary neonatal intensive care unit in Turkey. Am J Perinatol. 2014;31:335-8.
14. Andreoli SP. Acute renal failure in the newborn. Semin Perinatol. 2004;28:112-23.
15. Kara A, Gurgoze MK, Aydin M, Taskin E, Bakal U, Orman A. Acute peritoneal dialysis in neonatal intensive care unit: An 8-year experience of a referral hospital. Pediatr Neonatol. 2018;59:375-9.
16. Stojanoviæ VD, Bukarica SS, Antiæ JB, Doronjski AD. Peritoneal dialysis in very low birth weight neonates. Perit Dial Int. 2017;3:389-96.
17. Tetta C, Bellomo R, Ronco C. Artificial organ treatment for multiple organ failure, acute renal failure, and sepsis: recent new trends. Artif Organs. 2003;27:202-13.

Web Table I Clinical and Laboratory Features of Premature Neonates Before and After Peritoneal Dialysis

S.No.	*Sex*	*Gest age (wk)*	*Weight (g)*	*Underlying causes*	*PD starting age (d)*	*PD duration (d)*	*Pre/post pH**	*Pre/post sodium (mmol/L)*	*Pre/post potassium (mmol/L)*	*Pre/post urea (mg/dL)*	*Pre/post creatinine (mg/dL)*	*Outcome*	*Cause of death*
1	M	27	1060	PDA	1	4	7.50/7.50	130/131	3.6/3.6	12/10	1.6/0.9	Survived	-
2	M	27	493	Sepsis/PDA	3	3	7.05/7.35	128/144	5.4/5.5	26/9	2.5/0.8	Died	Pulmonary hemorrhage
3	M	29	1130	NEC	18	11	7.20/7.35	141/142	5.3/5.3	62/63	1.9/1.9	Died	Gastric perforation
4	F	23	635	NEC/PDA	13	3	7.10/7.11	141/141	5.2/5.1	51/50	1.2/1.3	Died	NEC
5	F	27	770	PDA/NEC	5	3	7.11/7.35	144/143	3.5/3.4	26/25	1.9/1.9	Died	Twin-twin transfusion
6	M	22	480	PDA	5	1	7.11/7.11	144/144	6.7/6.7	50/53	1.1/1	Died	Metabolic disturbances
7	M	22	520	NEC/PDA	7	8	7.14/7.14	160/160	5.8/5.7	118/115	2.9/2.7	Died	Immaturity
8	F	23	1050	NEC/PDA	12	3	6.90/6.93	154/155	6.5/6.6	148/150	5.4/5.1	Died	Electrolyte disturbances
9	M	29	920	Asphyxia/PDA	3	2	7.11/7.11	138/138	8.3/8.1	24/22	1.9/2	Died	Asphyxia
10	F	26	640	NEC/PDA	6	18	7.17/7.35	148/143	7.6/3.5	124/120	2.8/3	Died	Pulmonary hyper-tension
11	M	23	590	Sepsis/PDA	24	3	7.03/7.40	130/132	6.1/6	64/70	1.8/1.6	Died	Broncho-pneumonia
12	M	28	650	Sepsis/NEC	83	2	7.20/7.38	141/140	5/5.3	67/9	1.5/0.8	Survived	-
13	F	27	1200	NEC/PDA	11	1	7.15/7.15	132/131	4.8/5	87/85	2.8/3	Died	Sepsis
14	M	22	470	PDA	10	3	7.19/7.40	140/140	7.8/8	122/120	2.2/2.2	Died	Immaturity
15	F	29	1235	Hydrops fetalis	4	1	6.90/6.90	122/125	10/9	83/87	3/3	Died	Hydrops
16	M	24	720	Sepsis/NEC/PDA	14	2	7.45/7.45	120/145	6.2/4	94/13	1.9/0.7	Survived	-
17	F	25	830	Sepsis/NEC	6	1	7.30/7.30	152/152	8/7	125/120	3.3/3.5	Died	Sepsis
18	M	26	1005	Hydrops fetalis	7	4	7.30/7.45	139/140	7/6.5	9/12	1.2/1.1	Died	Hydrops
19	F	29	1010	Asphyxia	11	6	6.92/7.30	135/132	3.9/4	10/10	1.3/1.5	Survived	-
20	F	24	480	Sepsis/PDA	5	2	7.15/7.35	140/141	6.3/6.1	130/100	5.7/5.5	Died	Sepsis
21	F	23	460	Sepsis/PDA	3	1	7.20/7.20	150/151	5/5	119/115	5.5/5	Died	Immaturity

*Gest: gestational; NEC: necrotizing enterocolitis, PDA: patent ductus arteriosus, PD: peritoneal dialysis; *P<0.05 before and after PD.*