Successful Peritoneal Dialysis in an Extremely Preterm Infant

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ABSTRACT
Peritoneal dialysis can be considered renal supportive therapy, even in an extremely low birth weight infant with acute kidney injury not responding to general supportive measures. Although there have been several reports of successful peritoneal dialysis in extremely low birth weight infants, general practice guidelines and commercially available optimal peritoneal dialysis catheters have not been introduced. We report a successful case of peritoneal dialysis in an extremely low birth weight infant born at 25 weeks gestational age, with birth weight 790 g, with uncontrollable metabolic acidosis, hyperkalemia, progressive azotemia and continued anuria.

Key Words: Acute kidney injury, Peritoneal dialysis, Infant, Extremely low birth weight

INTRODUCTION
A refractory anuric preterm infant poses an ethical challenge for the attending doctors as well as for the parents. Peritoneal dialysis (PD) is generally considered the optimal dialysis modality for neonates because it is a simple procedure and can be initiated in hemodynamically unstable patients. Despite some complications associated with PD, it can be life-saving in emergency situations such as metabolic acidosis, hyperkalemia, and fluid overload. PD can be considered renal supportive therapy (RST) in infants with acute kidney injury (AKI) not responding to diuretics.

However, the decision to offer PD to low birth weight infants is difficult because of numerous problems including lack of availability of appropriately sized dialysis catheters, proper PD prescription, technical issues related to catheter placement, and individual physician practice. Although there is a number of literatures describing successful PD in preterm infants in other countries1-3, and one article including several reports of successful PD in extremely low birth weight (ELBW) infants in Korea4, but these provide limited information about a practical PD prescription. Here, we report a case of an ELBW infant with AKI not responding to diuretics and successfully treated with PD for 12 days.
CASE REPORT

The patient was a male infant born at 25\textsuperscript{+6} weeks gestation, weighing 790 g in Korea University Anam Hospital. He developed respiratory distress and required endotracheal intubation and surfactant. Echocardiographic evaluation on day of life (DOL) 3 showed hemodynamically significant patent ductus arteriosus (PDA), and ibuprofen was administered from DOL 3 to 5. On DOL 14 (post menstrual age [PMA] 27\textsuperscript{+5} weeks), he experienced pulmonary hemorrhage and hypotension, requiring pressor support with dopamine, dobutamine, hydrocortisone, and epinephrine.

On DOL 15 (PMA 27\textsuperscript{+6} weeks), his urinary output decreased to 1 mL/kg/hour despite fluid and diuretic therapy. His weight was 940 g, a 19% increase from birth weight. Over the course of this period, he developed worsening electrolyte abnormalities including metabolic acidosis, hyperkalemia, and hyponatremia, in addition to increasing serum blood urea nitrogen and serum creatinine levels. In spite of intensive medical treatment, elec-

![Figure 1](http://dx.doi.org/10.5385/nm.2016.23.3.158)
troleum imbalance worsened and the patient’s clinical condition deteriorated, with development of generalized edema (Figure 1).

He developed seizures on DOL 21 (PMA 28.5 weeks), probably because of hyponatremia and brain edema due to AKI. The laboratory results on the day of seizure showed serious electrolyte imbalance, and results of the renal parameters indicated severe renal failure. The patient did not respond to medical management and was anuric for over 2 days. On DOL 22 (PMA 28.6 weeks), the infant’s weight was 1,140 g, indicating a 44% fluid weight gain since birth. The neonatology and pediatric surgery team reviewed the risks and benefits of RST with the infant’s family, and PD was initiated for uncontrollable metabolic acidosis, hyperkalemia, progressive azotemia, and continued anuria.

A standard cuffed PD catheter was too large for an ELBW infant’s small abdominal cavity. Instead of a true PD catheter, a 6-F all silicone Foley catheter (Yushin medical, Korea) was placed in the abdominal cavity at bedside by a pediatric surgeon. A small stab incision was made in the right lower abdominal area and the catheter was directed into the abdominal cavity. Catheter placement was confirmed by radiograph. However, the PD catheter became obstructed and catheter replacement (8-F feeding tube) was peformed on the third day of PD (Figure 2).

The initial PD prescription included 10 mL volume (10 mL/kg/per exchange) inflow for 10 minutes and dwell time for 30 minutes, followed by drain time for 20 minutes. Manual PD was performed using 1.5% dialysate for 24 cycles per day. To optimize ultrafiltration, the dextrose concentration of the dialysate was sequentially increased to 2.5% and 4.25%. Additionally, dwell volume was increased to 20 mL (20 mL/kg based on ideal weight for PMA), and dwell time and drain time were increased to 90 minutes over time as tolerated. As the patient started diuresis, his clinical and laboratory results improved and the PD intensity and frequency decreased to 6 cycles per day.

On DOL 23 (PMA 29.0 weeks), the patient began to produce small quantities of urine. After 12 days of peritoneal dialysis, his urine output increased to over 1-4 mL/kg/hour and uremia improved. During the use of PD, the patient had one episode of catheter obstruction requiring revision, and he experienced some minor leakage around the exit site, without any acute infectious complications. He developed severe bowel distension without evidence of necrotizing enterocolitis and PD was discontinued on DOL 33, after 12 days of PD. During trials off PD, the infant maintained stable electrolyte balance and had adequate urine output. Laboratory results of renal parameters improved prior to discharge to a blood urea nitrogen level of 9.5 mg/dL and serum creatinine level of 0.33 mg/dL.

At the time of discharge, the patient was PMA 60.1 weeks and weighed 5,540 g. He was discharged without any respiratory support and had no feeding problems. The infant was diagnosed with bronchopulmonary dysplasia, periventricular leukomalacia, retinopathy of prematurity, and mechanical obstruction due

Figure 2. Radiograph shows replaced PD catheter (8-F feeding tube) in the abdominal cavity after obstruction on the third day of PD. Abbreviation: PD, peritoneal dialysis.
to meconium 20 days after discontinuing PD. His condition is regularly monitored by a pediatric neonatologist in the outpatient clinic.

**DISCUSSION**

To our knowledge, there have been several reports of successful PD in preterm infants, but it is difficult to find literature offering detailed information about optimal PD in ELBW infants. We would like to share our experience of an ELBW infant with AKI in Korea, who was successfully treated with PD by using an improvised catheter for 12 days. The use of PD in ELBW infants is technically feasible and has a theoretical advantage in the premature neonate because of the large peritoneal surface area to body ratio that provides improved dialysis efficiency.

However, in small infants, high rates of PD-related complications occur because of small body size. Limited available literature describing the use of PD in ELBW infants reports high rates of technical complications (25-60%) and mortality (>50%). Reported complications in infants include peritonitis, exit site infections, leakage around the exit site, catheter obstruction requiring revision, catheter removal, occlusion, hyperglycemia, abdominal wall hernias, and bowel perforation because of erosion from the dialysis catheter tip. Our infant had one episode of catheter obstruction and minor leakage around the exit site, without any acute infectious complications. At first, the poor drainage was managed by flushing with saline, but this was not successful; the 6-F all silicone Foley catheter was removed and an 8-F feeding tube was inserted. Minor exit site leakage was managed with povidone or chlorhexidine care, and the patient showed no sign of skin infection. Sojo et al. have shown that the application of 1 mL fibrin glue to the peritoneal cuff suture during catheter insertion will prevent early dialysate leakage without any adverse effects.

Additionally, PD in neonates is often deferred by clinicians because of lack of size specific equipment. The available data report the use of various catheter types, both commercial and improvised, for PD in low birth weight infants. Unal et al. used a rigid catheter placed at the level of the umbilicus in 20 neonates with weight ranging from 1,120 to 4,570 g. This technique was easy to perform in neonates but was associated with a high rate of catheter related complications (40%) such as infection, leakage, gross hemorrhage, removal, and obstruction. More over, owing to the limited space in the peritoneal cavity in ELBW neonates, it is difficult to place a rigid peritoneal catheter, which is why alternatives are explored. Stojanovic et al. placed a large-bore intravenous cannula (24-G) in the left umbilical region in a 470 g ELBW infant. This improvised device was prone to early leakage of the dialysate and kinking of the cannula. Harshman et al. documented successful use of an 8.5-F, 8-cm standard commercially available PD catheter in an 830 g ELBW infant requiring PD. However, a true PD catheter for a low weight infant may be unavailable in emergency situations requiring PD in the average Korean hospital. We used a readily available Foley catheter and a feeding tube, and suggest that the catheter should be considered for acute PD access in neonates.

The initial PD cycle for our ELBW infant included 10 mL volume (10 mL/kg/per exchange) inflow for 10 minutes and dwell time for 30 minutes, followed by drain time for 20 minutes. It is important to balance the dwell time and dialysate volume to optimize the ultrafiltration and blood purification of solute. There is no consensus on the dialysis prescription for low weight infants, but an initial empiric dwell time of 1 hour is often used in infants, although consideration has to be made for clearance of larger molecules that would be favored by longer dwells. Longer dwell time favors higher creatinine and phosphate clearance, but can cause ineffective ultrafiltration and dialysate reabsorption because of the loss of glucose related osmotic gradient. Shorter dwell time favors urea purification and facilitates ultrafiltration of water. However, too short time with low dwell volume can cause low creatinine clearance and decreased solute purification.

Dialysate volume for an infant should be based on weight or body surface area and determined by patient tolerance. PD dialysis can be initiated at a volume of 10 mL/kg, and can be increased up to 30-40 mL/kg as tolerated. Large dialysate volume improves creatinine clearance and enhances ultrafiltration of water due to increased hydrostatic pressure. However, too large dwell volume decreases ultrafiltration because of enhanced lymphatic uptake and increases the risk of respiratory compromise, leakage, hernias, and gastro-esophageal reflux. In contrast, overly small dialysate volume can cause impaired ultrafiltration. It is also possible to achieve enhanced ultrafiltration in anuric patients with a higher glucose concentration dialysis solution.

Depending on individual patient needs, PD prescription can be modified based upon residual kidney function, clinical target, and peritoneal membrane function, which can be determined...
by a peritoneal equilibration test. For optimal dialysis, estimating the individual peritoneal equilibration rate is necessary to evaluate net ultrafiltration. However, recurrent blood and dialysate sampling can be highly risky in small infants, and there is no available data on the kinetics of PD in ELBW infants. Therefore, the dwell time was determined according to the creatinine, and electrolyte levels, metabolic status, and severity of edema. In our case, we increased the dwell volume to 20 mL/kg, and dwell time and drain time up to 90 minutes, depending on the response to PD. The dwell time, number of exchanges, and glucose concentration of dialysate were adjusted as the patient’s status improved and the dwell volume of 20 mL/kg was maintained until the end of PD.

We suggest that PD should be performed in patients with AKI not responding to conservative treatment, those who show signs of uremia (seizures or impaired cardiac function), metabolic acidosis, refractory hyperkalemia, and those suffering from fluid overload with respiratory compromise. When selecting a PD catheter, a readily available improvised catheter can be considered in acute situations. Moreover, in PD for ELBW infants, increasing the dwell volume, dwell time, and outflow time can be effective. We believe that this case supports the consideration of PD in ELBW infants after evaluation of individual circumstances and comorbidity.

REFERENCES