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Peritoneal Dialysis in Extremely Low Birth Weight Baby using Chronic PD Catheter

Abstract

Acute kidney injury (AKI) and fluid overload are serious and common complication in premature babies and may increase morbidity and mortality. Renal replacement therapy should be considered for babies who fail medical interventions. Peritoneal dialysis (PD) is considered a safe and practical option for premature infants by producing efficient gentle removal of solutes and excessive water. There are few reports of PD done in extremely low birth weight (ELBW) infants. Acute PD catheters commonly used in children are reported to have more complications thus seldom used in premature babies. Several authors report using regular intravenous or central venous catheters to dialyze premature babies. We describe an ELBW (700g, twin A) infant born at 24 weeks gestation, who was dialyzed on the 34th day (910g) via pediatric size chronic PD catheter. Filling and drainage of PD fluid were performed manually. We encountered few complications and they were easily controlled. The dialysis resulted in normalization of serum creatinine and correction of fluid and electrolyte imbalance within 10 days. The infant continued to grow and eventually was discharged in good condition, with normal renal function at an adjusted age of 40 weeks (term).

Keywords: Catheter; Premature babies; Peritoneal Dialysis;

Case Report

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Rui Juan He[1]*, Maher Eldadah[1] and Wei Cheng[2]

[1]*Pediatric department, Beijing United Family Healthcare, China*

[2]*Pediatric surgical department, Beijing United Family Healthcare, China*

***Corresponding author:** Rui Juan He, Department of pediatrics, Beijing United Family Healthcare, #2 Jiangtai Rd, Chaoyang District, Beijing, China 100015, Tel: +861-343-670-6175.

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Abbreviations: PD: Peritoneal Dialysis; AKI: Acute Kidney Injury; ELBW: Extremely Low Birth Weight; g: Gram; NICU: Neonatal Intensive Care Unit; GA: Gestational Age; PDA: Patent Duct Arteriosus

Background

Acute kidney injury (AKI) is a complex disorder characterized by a sudden impairment in kidney function, which results in the retention of fluid and nitrogenous waste products and electrolyte imbalances. Of the neonates admitted to the neonatal intensive care units (NICU) up to 24% develop complications leading to AKI [1]. Prematurity and very low birth weight are independent risk factors for mortality [2,3]. Renal replacement therapy is indicated when conservative and medical treatment is ineffective. The decision to initiate dialysis in a small baby is complicated by many challenges including lack of size-appropriate dialysis catheter, unavailable dialysis machines designed for neonates, technical difficulty related to placement of catheter and individual lack of experience with PD. Limited literature exists describing the use of PD in ELBW infants. Additionally, complications and evident mortality rates have been reported [4,5]. For these reasons, neonatologists may be hesitant to proceed with dialysis and therefore may resort to restricting fluid and protein intake. We present a case of 700 g premature infant with AKI, who successfully underwent PD using surgically placed Tenckhoff catheter.

Case Presentation

Twin A delivered to a mother who had significant difficulties with conception. The mother had premature labor and amniotic membranes ruptured at 24+1 weeks gestational age (GA). Emergency C-section was performed due to threatening abortion. Twin A was female weighing 700g with good Apgar score (7-9-10 at 1-5-10min). She was intubated after birth and given 120 mg surfactant (curosurf, poractant alfa, Chiesi Farmaceutici S.P.A). Mechanical ventilation was initiated. Intravenous fluid with 10% glucose water and antibiotic therapy were administered. Parenteral nutrition was started on the 2nd day of life. During the following weeks supportive treatment included transfusion of packed red blood cells, use of diuretics, and thoracentesis for pneumothorax. A heart murmur was detected on the 3rd day of life, confirmed by echocardiogram as a patent duct arteriosus (PDA 4.5 mm), ibuprofen was given and the PDA closed. However, on the 24th day of life the PDA re-opened and caused feeding intolerance, pulmonary congestion and increasing ventilation. The PDA was surgically ligated on the 29th day of life. Prophylactic cafazolin was given for 3 days.

Since the 32nd day of life the baby developed generalized edema, decreased urine output and rising serum creatinine. Her weight increased from 990g to 1250g quickly. She was diagnosed with AKI. Conservative medical management was initiated (fluid restriction, colloidal fluid supplement, loop diuretic and low dose dopamine infusion). The baby showed slight clinical improvement initially, but her condition progressively worsened and her serum creatinine rose to 240umol/L. The decision was made to attempt PD since the AKI was likely to be reversible. The parents consented to the procedure.

After discussing the various catheter choices, such as venous catheter, trocar catheter, or Tenckhoff catheter, the decision was made to place a Tenckhoff due to its softness and biocompatible

nature. The smallest available Tenckhoff catheter (Pediatric Tenckhoff catheter SP1230, 30cm totally and 12cm from tip to Dacron cuff) was used and placed surgically. A 3-cm horizontal incision was first made above the umbilicus over the left rectus abdominis muscle and then the muscle was separated by blunt dissection. The Tenckhoff catheter primed with saline was advanced through dilator using Seldinger technique pointing slightly rightwards in front of the bowel loops in an attempt to avoid direct contact with iliac vessels. The catheter was finally advanced to the rectovesical pouch, with Dacron cuff against the rectus abdominis. A 5/0 Vicryl purse-string suture of the peritoneum around the catheter was performed to ensure a tight seal of the abdominal cavity in an attempt to prevent leakage. A tunnel was then established subcutaneously and the catheter exited in the right upper quadrant (Figures 1 & 2).

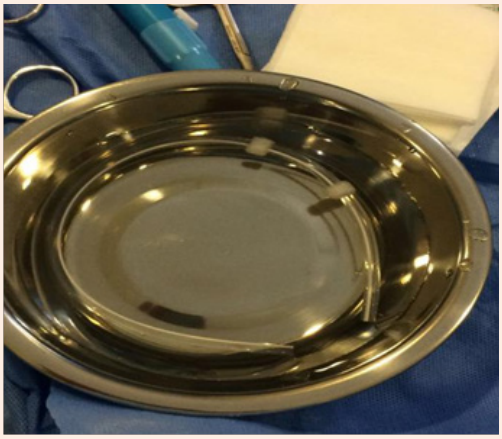

Figure 1: Pediatric Tenckhoff catheter.

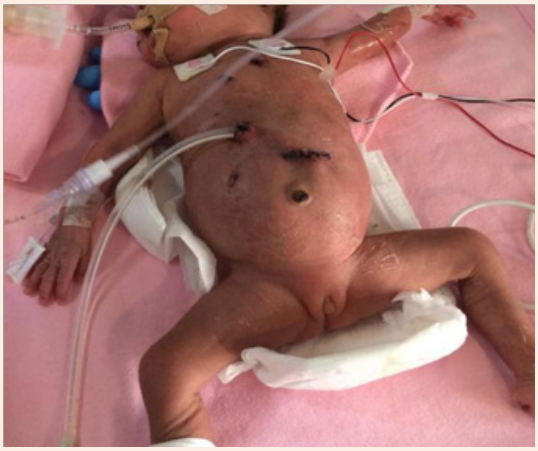

Figure 2: Catheter location.

The Tenckhoff catheter was connected to a closed system for PD (Figure 3). 2 three-way stopcocks were used for manual filling and drainage. Installation of PD fluid was carried out using a 20 ml syringe to siphon dialysate from the bag and manually fill the peritoneal space. After the dwell, the PD fluid was drained into the drainage bag via gravity. PD was started with a dwell volume of 10ml for 40 minutes. The fill and drain time were 10 minutes each (total of 60 minute cycles). Standard commercial preparation dialysis solution was used (Low Calcium peritoneal dialysis solution, 2L by Baxter International Inc. and the dextrose concentration varied from 1.5% to 2.5%). Heparin (500μ/L of the dialysate) and potassium chloride were added based on patient's condition and potassium level, and the choice of dextrose concentration was dependent upon the desired fluid removal and patient's volume status. PD was started 24 hours following catheter insertion with an initial dialysis solution of 1.5% dextrose. There was slight leakage of dialysis solution on the first day, which resolved once the PD catheter was pulled out slightly. The drainage was bloody on the 2nd day so heparin added into the dialysis fluid was discontinued, and vitamin K plus fresh frozen plasma were given. Prophylactic cefazoline was used for 3 days. Stat biochemistry was performed daily to follow electrolytes and creatinine. Albumin was given 500mg/kg every other day for hypoalbuminemia. There was no peritonitis, hypo/hypertension or other mechanical complications after the second day.

Manual PD technique: two three-way stopcocks facilitated the filling and drainage. During the filling phase, stopcock② was closed towards stopcock, the dialysis fluid was manually aspirated into the syringe, then stopcock② was closed towards the dialysate while stopcock② was closed towards the drainage bag. When the filling phase is completed, stopcock② is turned off towards the PD catheter for dwelling. Finally, stopcock② is opened to allow drainage into the drainage bag for 10 minutes. The dialysis bag and system were kept inside the baby's isolette to keep warm.

Her condition and anasarca improved gradually with PD. Her urine output increased daily and serum creatinine normalized within 10 days of starting PD (Figure 4). Electrolytes and serum glucose remained normal throughout the dialysis period. PD was discontinued after 10 days and the PD catheter was removed on the 11th day (44th day of life). She was weaned from respiratory support on the 65th day of life. She was off parental nutrition and on total nipple feeding by the 80th day of life. She was discharged on 115th day of life weighing 2785g.

Creatinine level throughout hospital stay. PD catheter was placed at Nov 4th and dialysis began at Nov 5th. Effective dialysis started from Nov 7th. Peak creatinine was on Nov 7th and declined rapidly with initiation of PD.

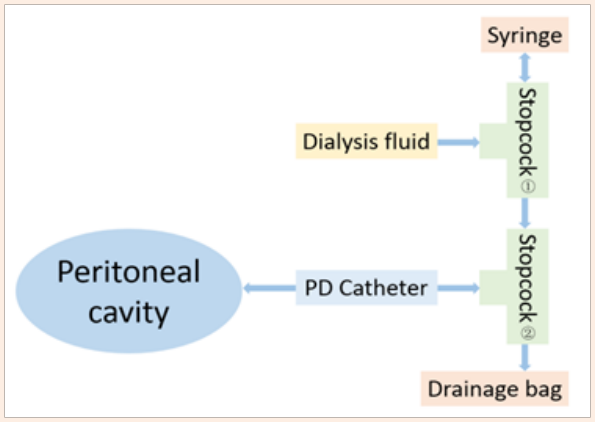

Figure 3: Manual PD technique.

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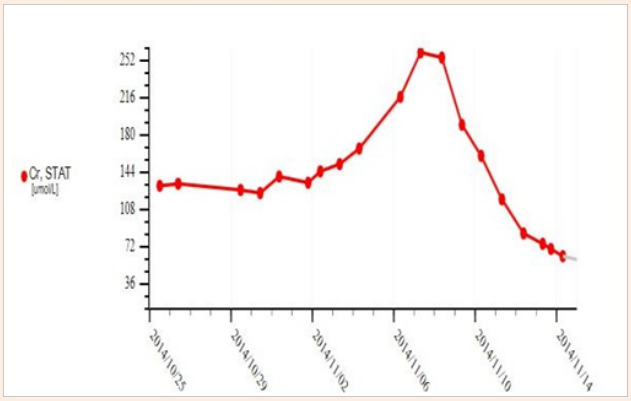

Figure 4: Creatinine level throughout hospital stay.

Discussion

AKI is fairly common in ELBW infants and may be due to such factors as incomplete nephrogenesis of kidneys, use of nephrotoxic medications (antibiotics and diuretics), perinatal asphyxia and hypoperfusion [2]. PD has been reported as a safe and effective way to treat AKI when conservative therapy fails. To our knowledge, our case report includes the smallest infant with whom PD was successfully performed via a surgically placed chronic pediatric-size PD catheter. This PD catheter has traditionally been considered too large for small premature babies and many doctors may not consider its use due to fear of causing patient compromise. However, other catheters reported in the literature may not offer a significant advantage and in fact, dialysis performed with those catheters are usually inefficient and have high complication rates. Tenckhoff catheter has been proven to be safe and effective in adults and children. Its soft and biocompatible nature allows it to be left in place indefinitely, the subcutaneous tunnel and Dacron cuff allows permanent and secure fixation, and the large bore of the catheter allows good and reliable flow [6]. However the regular pediatric size with lengths from 30cm to 39cm is too large for an ELBW infant's small abdomen. In order to accommodate the catheter length, the surgeon made a subcutaneous tunnel and exited the catheter in right upper quadrant. He used the cuff and a purse-string suture to successfully control the leakage and infection. Manual dwelling and drainage was utilized due to lack of size-specific equipment. The complications we encountered were minimal and easily managed.

AKI requiring dialysis and mechanical ventilation are poor prognostic factors in the NICU [7]. However, some studies have shown that early initiation of dialysis in neonates and infants with AKI was associated with a significant decrease in morbidity and mortality [8,9]. Many babies with AKI are treated with conservative medical management and dialysis is delayed. The most common rationale for delaying dialysis is lack of appropriate size catheter and lack of appropriate size dialysis machines. In our case report, we demonstrated that a commercially available pediatric size PD catheter could safely be inserted in a very small premature baby. In addition, PD can efficiently be performed using manual technique to treat ELBW infants with AKI. This approach has relatively low-cost, requires no additional equipment and is technically simple. It took minimal time and resources to train each nurse to perform the dialysis manually. The manual dialysis fluid exchange had excellent tolerance in our patient who was hemodynamically unstable.

Contributors' Statement

Rui Juan He: Dr. He reviewed the records, wrote the initial draft, prepared the figures and pictures and approved the final manuscript as submitted.

Maher Eldadah: Dr. Eldadah reviewed the case for accuracy, revised the manuscript as provided and approved the final manuscript as submitted.

Wei Cheng: Dr. Cheng placed the catheter and wrote the surgical description of the procedure. He also edited and revised the manuscript and approved the final manuscript as submitted.

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