Complications of Acute Peritoneal Dialysis in Children with Acute Kidney Failure

Khemchand N Moorani\textsuperscript{1}, Jai Parkash\textsuperscript{2}, Harilal\textsuperscript{1}

Department of Pediatric Nephrology\textsuperscript{1}, Department of Neonatology\textsuperscript{2},
National Institute of Child Health, Karachi.

Abstract

Background: Acute kidney injury is the sudden failure of kidneys to maintain body homeostasis and acute peritoneal dialysis is a life saving bedside mode of its management. However, complications like peritonitis, leakage, obstruction and malposition of catheter can occur during acute peritoneal dialysis.

Objectives: To document the immediate complications of acute peritoneal dialysis in children having acute kidney injury.


Subjects and Methods: Children between 1 month to 14 years of age who had acute kidney injury and underwent acute peritoneal dialysis were included in the study. All had standard indications for dialysis, catheter insertion technique and manual exchanges. Data including age, gender, indications, cause of acute kidney injury and complications, were computed on SPSS -10 and analyzed using descriptive statistics.

Results: A total of 126 children underwent acute peritoneal dialysis for various indications and among them 60 developed different complications. There were 34(56.6\%) boys and 26(43.3\%) girls with a mean age of 4.7 years. Indications for acute peritoneal dialysis were oligo-anuria in 52(86.6 \%), metabolic acidosis in 42(70\%), fluid overload in 32(53.3\%), uremia in 27(45\%) electrolyte imbalance in 17(28.3\%) and severe hypertension in 2(3.3\%). Etiologies for acute kidney injury were sepsis in 15(25\%), renal calculi in 14(23.3\%), congenital obstructive uropathy in 10(16.7\%), acute gastroenteritis in 7(11.7\%) and hypoplastic kidneys in 6(10\%) cases. Mean duration of acute peritoneal dialysis was 5.2 days. Documented complications were peritonitis in 19(31.7\%), catheter obstruction in 13(21.7\%), leakage and catheter displacement in 11(18.3\%), bleeding and other complications in 3(5\%).

Conclusions: Acute peritoneal dialysis is a life saving procedure. Peritonitis, catheter obstruction, leakage and displacement were the common complications.

Policy message: Peritoneal dialysis for children should be available at all tertiary care hospitals and its staff should undergo regular training to manage the complications.

Key words: Acute peritoneal dialysis, complications, peritonitis, acute kidney injury, children.

Introduction

Acute kidney injury formerly referred to as acute renal failure is a reversible, sudden reduction in renal function, characterized by raised blood urea nitrogen and serum creatinine (>50\% of normal). In most cases, there is concomitant reduction in urine output (<0.5-1ml/kg/hour\textsuperscript{1}). Acute kidney injury may also be presentation of chronic kidney disease particularly in developing countries where there are limited medical facilities, late diagnosis and treatment. It is an important cause of morbidity and mortality in critically ill children\textsuperscript{2,3}. It accounts for 2-3\% of admissions in pediatric tertiary care centers and 1.4-13\% of all renal cases in Pakistan\textsuperscript{4,5}. Acute kidney injury is observed in 3–5\% of pediatric and neonatal intensive care units (ICUs) admission and has been associated with mortality rate of 40-50\% in developed countries\textsuperscript{6}.

The incidence and demographic profile of children with acute kidney injury requiring renal replacement therapy in developing countries is not been well documented\textsuperscript{7,8}. A study on renal replacement therapy from our institute showed almost 17\% admissions in general pediatric ward due to renal failure and 65\% of them underwent renal replacement therapy either as acute peritoneal dialysis or acute hemodialysis\textsuperscript{8}.

Management of children with established acute kidney injury is challenging and its conservative management goals include correction of fluid, acid-base and electrolyte imbalance, control of hypertension,
treatment of infection if present, the treatment of underlying cause and avoiding further renal injury like use of nephrotoxic drugs. All these measures and timely initiation of renal replacement therapy are directed to improve survival time till renal recovery takes place\textsuperscript{1,6-8}. Acute renal replacement therapy can be performed using acute peritoneal dialysis, acute haemodialysis and continuous renal replacement therapy\textsuperscript{7,9}. Overall, continuous renal replacement therapy is preferred mode of dialysis for acutely ill children, but peritoneal dialysis remains the commonly used modality in children below 6 years\textsuperscript{6}.

The choice of renal replacement therapy depends upon patient’s age, underlying renal disease, specific goals for dialysis, cardiopulmonary status of patient and the availability of dialysis disposables and technical expertise\textsuperscript{6,9}. Among the several advantages that peritoneal dialysis offers, relatively low cost is the most important and it is more so when manual exchanges are used as in developing countries. Other advantages include technical simplicity, no need for anticoagulation or placement of a central venous catheter, excellent tolerance in hemodynamically unstable patient\textsuperscript{2,3,6,7}.

In peritoneal dialysis, the solutes and fluid are exchanged between the peritoneal capillary blood and the dialysis solution in the peritoneal cavity through peritoneal dialysis catheter. Acute peritoneal dialysis can easily be initiated with minimum equipment and paramedical expertise. It is preferred over hemodialysis in cases of acute kidney injury associated with bleeding tendency, hypotension and cardiovascular instability since it runs continuously with slow chemical changes and without risk of dialysis disequilibrium syndrome. It is the treatment of choice for neonates and infants due to technical reasons\textsuperscript{8,10}. Acute manual peritoneal dialysis, a safe and effective form of treatment for acute kidney injury which is a life saving procedure in developing countries like Pakistan\textsuperscript{3,5,10-12}, but is less often performed in the developed world. Problems associated with the procedure include the use of rigid disposable catheters and peritonitis. There is a 60-90% risk of developing peritonitis in long term (1-3 years) peritoneal dialysis, but this risk in acute peritoneal dialysis has not been well documented\textsuperscript{6,9}. Leakage of peritoneal dialysis fluid at catheter insertion site, displacement of catheter and obstruction to drainage are other common complications\textsuperscript{9}. There are few studies carried out in Pakistan on the use of acute peritoneal dialysis in children and adults\textsuperscript{5,11,12}. In two pediatric studies comprising each of 88 and 50 children, the most common reported complication was peritonitis and abdominal pain found in 36(41%) and 20(40%) cases respectively\textsuperscript{5,11}.

This study was undertaken to share our experience of acute peritoneal dialysis at Pediatric Nephrology unit of National Institute of Child Health and to increase the awareness among the pediatricians about acute peritoneal dialysis and its complications. Subjects and Methods

This descriptive cases series was carried out in the department of Pediatric Nephrology at the National Institute of Child Health, Karachi, over one year from July 2007 to 2008. All children between 1 month to 14 years of age of both genders presenting with acute kidney injury, who underwent acute peritoneal dialysis during this period were included in the study, but case records of only those who developed complications were further analyzed. Acute kidney injury was defined as any child who presented with clinical and biochemical evidence of kidney damage and required immediate dialysis treatment, irrespective of underlying cause. All children with acute kidney injury and acute- on- chronic kidney disease who required immediate peritoneal dialysis, were included and those with recent abdominal surgery were excluded.

Indications of acute dialysis included fluid overload (pulmonary edema, congestive cardiac failure or hypertension refractory to therapy), persistent hyperkalemia (serum K >6 Meq/L), intractable metabolic acidosis (pH \< 7.2 or serum HCO\textsubscript{3} \<10 Meq/L), rising trend of blood urea and creatinine, symptomatic uremia (vomiting, loss of appetite), neurological manifestations (uremic encephalopathy) or metabolic disturbance like hypocalcaemia and hyperphosphatemia\textsuperscript{1}.

After informed consent from parents, children were catheterized (if not already), perisolution bags were connected with Y-connector set to complete the circuit and circuit was primed with perisolution. Patients were placed in supine position; peritoneal dialysis catheter (Pericat Serosep Rossalea, Limerick-Ireland) of appropriate size was inserted by pediatric resident under aseptic measures, after local infiltration of xylocaine. After priming of peritoneal cavity with 20-30 ml/kg of peritoneal dialysis fluid (perisolution), using 16/18 gauge intravenous cannula, a small nick was given in the abdominal wall and catheter along with trocar were passed in the peritoneal cavity. Just after the entry of the trocar in the peritoneal cavity, it was withdrawn 1-2 cm and the tip was advanced to position in the left iliac fossa. After ascertaining good flow, the tip was fixed with adhesive pressure dressing without stitches.

The dialysis was continued by the trained peritoneal dialysis technician with initial 4-5 rapid exchanges, following the basic principles of use of frequent continuous exchanges, with low volumes (10-20 ml/kg), each of one hour duration (inftime10, indwell 20 and drain 30 minutes respectively) with heparin 500U/L\textsuperscript{5,11}. The peritoneal dialysis cycle volume was gradually increased to a maximum of 50 ml/kg if no leakage or respiratory distress was seen. Patients were monitored for complications like bleeding, leakage or extravasations around insertion site, catheter blockage and displacement, peritonitis and exit site cellulitis.
Peritoneal dialysis fluid analysis, gram stain and culture sensitivity were sent daily and white blood cells of > 100 with > 80% polymorphs and/or positive gram stain or culture were taken as peritonitis. Daily urea, creatinine and electrolytes were monitored for hypokalemia and to assess the response to dialysis therapy in addition to clinical evaluation. Data of patients based on history, physical examination and laboratory investigations like urea, creatinine, arterial blood gases, serum electrolytes, calcium, phosphorus, complete blood counts, ultrasound of urinary tract and other relevant imaging studies for underlying cause of acute kidney injury was collected and entered on proforma.

Data was entered in computer program SPSS 10 and analyzed using descriptive statistics. Frequency and percentages were used for categorical variables like age groups, gender, under lying cause of acute kidney injury, indications for acute peritoneal dialysis and number and type of complications. Mean and standard deviation were used for numerical variables like age and duration of acute peritoneal dialysis.

Results

A total of 126 patients underwent acute peritoneal dialysis for renal failure during 1 year and 60(47.6%) children developed various complications. Out of 60, 34(56.6%) were boys and 26(43.3%) girls with a mean age of 4.7 years. Indications for acute peritoneal dialysis are shown in Table-1 which included oligo-anuria, metabolic acidosis and fluid overload in majority of cases. There were more than one indication in the same patient.

Table 1: Indications for acute peritoneal dialysis in patients with acute kidney injury. (N=60)

<table>
<thead>
<tr>
<th>Indications</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oligo-anuria</td>
<td>52</td>
<td>86.6</td>
</tr>
<tr>
<td>Metabolic acidosis</td>
<td>42</td>
<td>70</td>
</tr>
<tr>
<td>Fluid over load</td>
<td>33</td>
<td>55</td>
</tr>
<tr>
<td>Uremic symptoms</td>
<td>27</td>
<td>45</td>
</tr>
<tr>
<td>Electrolyte imbalance</td>
<td>17</td>
<td>28.3</td>
</tr>
</tbody>
</table>

Table 2: Etiology of acute kidney injury. (N=60)

<table>
<thead>
<tr>
<th>Causes</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sepsis</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Renal calculi</td>
<td>14</td>
<td>23.3</td>
</tr>
<tr>
<td>Cong. obstructive uropathy</td>
<td>10</td>
<td>16.7</td>
</tr>
<tr>
<td>Acute gastroenteritis</td>
<td>07</td>
<td>11.7</td>
</tr>
<tr>
<td>Dys-hypoplastic kidneys</td>
<td>06</td>
<td>10</td>
</tr>
<tr>
<td>Acute nephritic syndrome</td>
<td>05</td>
<td>8.3</td>
</tr>
<tr>
<td>Hemolytic uremic Syndrome</td>
<td>02</td>
<td>3.3</td>
</tr>
<tr>
<td>Complicated NS</td>
<td>01</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Sepsis followed by renal calculi and congenital obstructive uropathy were the main causes of acute kidney injury (Table-2). Mean duration of dialysis was 5.2 days with a range of 4-6 days.

Documented complications were peritonitis in 19, catheter obstruction in 13, leakage and catheter displacement in 11 cases each. There was no case of intestinal or bladder perforation (Table-3).

Table 3: Complications of acute peritoneal dialysis in patients with acute kidney injury. (N=60)

<table>
<thead>
<tr>
<th>Complications</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peritonitis</td>
<td>19</td>
<td>31.7</td>
</tr>
<tr>
<td>Obstruction</td>
<td>13</td>
<td>21.7</td>
</tr>
<tr>
<td>Leakage</td>
<td>11</td>
<td>18.3</td>
</tr>
<tr>
<td>Catheter displacement</td>
<td>11</td>
<td>18.3</td>
</tr>
<tr>
<td>Bleeding</td>
<td>03</td>
<td>5</td>
</tr>
<tr>
<td>Electrolyte imbalance</td>
<td>02</td>
<td>3.3</td>
</tr>
<tr>
<td>Exit site cellulitis</td>
<td>01</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Causative organisms of peritonitis were Staphylococcus aureus and E. Coli grown in 3 cases each (27.2%), other pathogens were Streptococcus pyogens and Pseudomonas in 2 cases each and Citrobacter in 1 case. Peritonitis was managed by readjustment of catheter position or flushing with rapid cycles of acute peritoneal dialysis followed by appropriate antibiotics. Removal of dialysis catheter was the last resort.

Discussion

This study showed a high frequency of complications associated with acute peritoneal dialysis in children such as peritonitis, catheter obstruction, leakage and catheter displacement. Acute kidney injury is uncommon in pediatric age group and accounts for 2-3% of children admitted in pediatric tertiary care centers in Pakistan. Acute dialysis is an important mode of treatment particularly in young infants and critically sick children. Available choices for acute dialysis are acute peritoneal dialysis, acute intermittent hemodialysis and continuous renal replacement therapy. Acute peritoneal dialysis is performed either using rigid stylet disposable catheter inserted by nephrologist or pediatric resident under local anesthesia or by using soft silicone Tenckhoff catheter placed under general anesthesia. In Pakistan, acute peritoneal dialysis is done at very few centers as a life saving bed side procedure in children with acute kidney injury or acute-on-chronic kidney disease who have no established vascular access for hemodialysis. It is done as exchanges of 20-24 one-hour cycles per day.

Disposable rigid catheter is commonly used for acute dialysis in children in Pakistan. Though these disposable catheters are inserted as bed side procedures but they are suitable for short period of dialysis and are life saving, but require extraordinary aseptic technique for
successful continuous running of exchanges and without complications and extra nursing care. That is why most of the centers are doing acute peritoneal dialysis in ICU setting. Other preventable complications of acute peritoneal dialysis are leakage of peritoneal dialysis fluid, obstruction or displacement of catheter, hemorrhage, accidental removal and rarely intestinal perforation. We used rigid disposable peritoneal dialysis catheter for short period (5 days) in a nephrology unit with trained staff and we had complications in 60(47.6%) cases. Mean age in the present study was 4.7 years with majority of patients being below 5 years of age which is consistent with the studies done locally.5,11 Male dominance seen in the present study was also similar to that reported by others.11

In the present study, the commonest indication for dialysis was oligo-anuria which is much higher than absolute anuria of 4% reported from Lahore12 and the reason for this disparity could be that they had 74% cases with chronic kidney disease explaining the normal urine volume in these cases. In the Lahore study12 metabolic acidosis and fluid overload were the indications in 26% cases each, in contrast to high figures seen in the present study. This could be due to higher number (65%) of newly diagnosed acute kidney injury in the absence of preexisting chronic kidney disease in our study. Similarly uremic symptoms (45%) were also higher than the 24% reported in the same study11 and this is also due to predominance of acute kidney injury rather than chronic kidney disease in our study. Also electrolytes imbalance (28.3%) in our study is much higher than the 8% of hyperkalemia reported by Saeed et al11.

The common causes or disease responsible for kidney injury in our study were sepsis, urinary calculi and congenital obstructive uropathy, while globally it is secondary to acute diarrheal losses and renal hypoperfusion after major surgery and secondary to systemic sepsis associated with multi-organ failure.6,17 Sepsis as cause of acute kidney injury was reported in 8% cases, obstructive uropathy in 20% and acute gastroenteritis in 11.6% from a study within Pakistan.11 All these figures are lower than those seen in the present study. Hemolytic uremic syndrome was found in 3.3% of cases in our study, which is lower than that reported from Lahore (8%)11 and it has also been reported as the most common cause of acute kidney injury in children below 4 years in Pakistan by others.11

Peritonitis was the commonest complication (31.6%) in this study which is much higher than 6% reported in a study from Lahore.11 Though peritonitis is preventable by using aseptic catheter insertion technique and change of connections during cycles but use of rigid catheter and manual exchanges for longer duration can lead to increased risk of peritonitis.12 Abdominal pain was commonest complication (40%) of peritoneal dialysis in the report from Lahore.11 Pain of milder severity is common in these children because of the rigid catheter, frequent postural change in children along with dialysis inflow pain, so we did not consider pain as a separate complication. Mechanical complications like catheter obstruction and leakage and displacement in the present study were comparable to those reported by others.11 The bleeding following catheter insertion in our study (5%) was much less than that reported from Lahore (24%). Variation in the frequency of complications are probably related to the dialysis facility setting, expertise in catheter insertion and the paramedical staff involved in the exchanges. Staphlococcus aureus and E-coli were the common organisms isolated from these cases and similar pathogens were reported in a previous study from the same institute and also from India.19,20

Acknowledgement

Authors are thankful to Mr. Michael Khokhar, Dialysis Manager, Pediatric Nephrology Unit for his help in collection of data of patients used in this study.

References