CONTINUOUS AMBULATORY PERITONEAL DIALYSIS IN SMALL CHILDREN WITH ACUTE RENAL FAILURE

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Summary

In the period January 1980 to January 1982 five small children with acute renal failure were treated with continuous ambulatory peritoneal dialysis (CAPD) to overcome the catabolic state of the anuric stage. A free diet was allowed during this period except for slight restriction in fluid intake. Weight gain was only observed in one child, whereas in the others no significant change of body weight was noticed. CAPD treatment was terminated as renal function improved and a creatinine clearance of 20ml/min/1.73m² was achieved.

Introduction

In children with acute renal failure (ARF) the early introduction of dialysis reduces the mortality rate [1–4]. Partly because of the catabolic state early and frequent dialysis is commonly applied to patients with ARF [5–8].

Haemodialysis (HD) is relatively easy to perform in older children (≥3 years), but in the younger child this is still complicated [9, 10]. Peritoneal dialysis (PD) is the treatment of choice in the majority of cases of ARF in the small paediatric patient.

Despite dialysis it remains difficult to overcome the catabolic state of the anuric stage [11, 12]. It is difficult to achieve an anabolic situation, particularly in the small child, where fluid balance must be regulated within very strict margins. Moreover paediatric patients generally do not cooperate with the necessary unattractive diet. CAPD offers an attractive solution because of the absence of dietary restrictions. In the last two years we have performed CAPD in five children with ARF caused by haemolytic uraemic syndrome (HUS).

Patients and methods

Five patients (three girls, two boys), three weeks to two years eight months old, with ARF were treated with CAPD. Four of the five children (two girls, two
boys), were referred with a HUS-associated ARF. The fifth child, a girl of three weeks, initially had the clinical features of cardiac failure and over-hydration, while HUS developed within a week of admission.

In view of the possibility of spontaneous remission of ARF in patients of this age-group with HUS, we applied short dwell time PD during the first 48 hours with a stiff catheter (Trocath®) inserted by puncture under local anaesthesia. Thereafter the catheter was removed.

If the patient remained anuric during the next 48 hours, we switched to CAPD. For this purpose a Tenckhoff® catheter is inserted under general anaesthesia and strict sterile conditions. During the first 24 hours frequent exchanges of dialysis fluid was maintained. Thereafter older children (≥ 1.5 years) are exchanged four times and younger children six times daily. The amount of fluid was gradually increased to 30–40ml/kg body weight.

Exchanges were performed by the paediatric nursing staff. The fluid bags, containing Dianec®17, were prepared by the CAPD nursing staff to fit the size of the child.

During this regimen the diet was free, with normal protein intake for age and only a slight fluid restriction. When creatinine clearance reached 20ml/min/1.73m² we removed the Tenckhoff catheter.

Results

Clinical and laboratory data are presented in Tables I and II. The duration of the oligo-anuria ranged from 12 days to 22 days (average 16.5 days). CAPD treatment ranged from 10 days to 33 days (average 21.5 days). Peritonitis occurred in four of the five patients. Bacterial cultures of the dialysis fluid were positive in two patients (4 and 5) containing E. coli and Strept. faecalis respectively. Protein intake was gradually increased to 2–3g/kg body weight, with the exception of patient 4, who could not take more than 1g/kg/day.

<table>
<thead>
<tr>
<th>TABLE I</th>
</tr>
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<tbody>
<tr>
<td>Patient</td>
</tr>
<tr>
<td>Age at onset</td>
</tr>
<tr>
<td>Period of oligo-anuria* (days)</td>
</tr>
<tr>
<td>Period of CAPD (days)</td>
</tr>
<tr>
<td>Incidence of peritonitis</td>
</tr>
</tbody>
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* ≤ 400ml/m²/day
**TABLE II**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Start</th>
<th>End</th>
<th>Start</th>
<th>End</th>
<th>Start</th>
<th>End</th>
<th>Start</th>
<th>End</th>
<th>Start</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight (kg)</td>
<td>7.04</td>
<td>6.95</td>
<td>12.30</td>
<td>12.20</td>
<td>14.80</td>
<td>14.80</td>
<td>13.20</td>
<td>13.40</td>
<td>2.80</td>
<td>3.15</td>
</tr>
<tr>
<td>Fluid intake (ml/day)</td>
<td>700</td>
<td>800</td>
<td>500</td>
<td>750</td>
<td>500</td>
<td>750</td>
<td>250</td>
<td>750</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Average protein intake (g/kg/day)</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total caloric intake (kcal/day)</td>
<td>500</td>
<td>1332</td>
<td>1390</td>
<td>600</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plasma creatinine µmol/L</td>
<td>500</td>
<td>90</td>
<td>740</td>
<td>70</td>
<td>600</td>
<td>85</td>
<td>480</td>
<td>150</td>
<td>400</td>
<td>75</td>
</tr>
<tr>
<td>Plasma urea mmol/L</td>
<td>33</td>
<td>25</td>
<td>32</td>
<td>10</td>
<td>32</td>
<td>10</td>
<td>50</td>
<td>8.0</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>Urine creatinine clearance ml/min/1.73m²</td>
<td>0</td>
<td>20</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>30</td>
<td>0</td>
<td>20</td>
<td>0</td>
<td>25</td>
</tr>
</tbody>
</table>

Data at the beginning and at end of CAPD treatment are given in Table II. Plasma urea could be kept between 8 and 15 mmol/L, creatinine between 200 and 350 µmol/L. Plasma sodium, potassium, calcium and phosphorus were normal in all children. Plasma glucose remained between 4–8 mmol/L. Serum albumin remained subnormal (30–40 g/L), with lower values (25–30 g/L) during peritonitis. Plasma bicarbonate was normal in all children except in patient 5 during the first two days of CAPD. Patient 5 was the only one to gain significant weight, i.e. 350 g in four weeks, the others maintained body weight.

**Discussion**

In experienced hands HD is difficult to perform in the small child. An external shunt is usually required and the smaller the child the greater the problems regarding technique, shunt clotting and haemodynamics [13, 14]. Compared with intermittent peritoneal dialysis (IPD), CAPD offers the following advantages: repeated punctures [15] of the peritoneal cavity are not necessary, immobilisation, an absolute necessity with a stiff catheter used in IPD [16], is not required, and there are no dietary restrictions, while fluid and electrolyte balance are continuously regulated [17].

The condition of the patients improved rapidly and full mobilisation was permitted, which stimulated appetite. Nevertheless total caloric intake was subnormal in some patients (Table II), but the amount of glucose absorbed from the dialysate adds a considerable amount to the daily dietary intake [18–20].
Despite using dialysis fluids containing high concentrations of glucose (2.27%; 3.86%), blood glucose concentrations never exceeded 8 mmol/L. Calculation of glucose absorption from the dialysate showed values of 10–15 g of glucose per day (patient 5). While anuric, fluid intake was restricted slightly in all patients. Thereafter the amount of fluid given was adjusted to the amount required. Periods of over-hydration were observed in the two small children (1 and 5) once and twice respectively. Short-dwell-time dialysis was therefore applied for 12 hours each to increase the ultrafiltration of fluid. Glucose absorption from the dialysate might be a possible explanation, although neither an excessive rise in

Figure 1. Laboratory and clinical values of patient 4. ◼ periods of over-hydration, treated with short-dwell-time dialysis
glucose nor a high serum osmolality (> 280 mosmol/L) were measured [21]. It is not surprising that this problem is more pronounced in younger than in older children.

Dianeal® was used without problem. Only once (patient 5) we had to exchange the lactate anion of the dialysis fluid for bicarbonate. This was during extreme metabolic acidosis caused by poor physical condition in the first two days of CAPD.

Peritonitis occurred in four of the five children, and a positive culture was obtained in two patients [22]. Addition of antibiotics to the dialysis fluid (Cephalosporin, in patient 4 combined with Gentamicin) gave good results in three patients. Removal of the catheter due to colonisation was necessary in patient 4. The details of patient 5 are shown in Figure 1. Over-hydration was overcome with short-dwell-time dialysis. By subsequently increasing the volume of the dialysis from 100 to 150ml per exchange this problem was avoided. As expected, fluid retention was observed during peritonitis. Loss of appetite and vomiting results in a lower protein intake during this period. When creatinine clearance rose to 25ml/min/1.73m² the CAPD procedure was stopped. Over the next six months the clinical condition of the child improved favourably and her weight is now 7000g and her length 72cm (respectively P₅₀ and P₄₀). Renal function is normal for age (creatinine clearance 70ml/min/1.73m²) except for a slight concentration defect. Psychomotor development is normal for age.

Acute PD at the beginning of the treatment is still advisable in view of the chance of spontaneous remission while improving the patient’s clinical condition in preparation for general anaesthesia.

In conclusion CAPD appears to be a practical form of dialysis for the infant and small child with ARF. In our limited series of five children we have been able to overcome the catabolic consequences of ARF allowing a fully nutritional and attractive diet [23]. It is our impression, that this form of dialysis has a less traumatic psychological impact.

Acknowledgments

We wish to thank the nursing staff of the paediatric and CAPD department for their cooperation and Miss C W van den Berg for secretarial help.

References

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Open Discussion

BROYER (Paris) We have no experience with CAPD for acute renal failure in young children but we are currently using a permanent Tenckhoff catheter for IPD thereby avoiding multiple punctures.

ABBAD Which form of IPD do you use, the chronic form or the IPD used in acute renal failure?

BROYER We prefer the permanent catheter inserted surgically as for CAPD. Afterwards we perform IPD for three or four days weekly according to parameters.

ABBAD In the acute phase?

BROYER Yes, for acute renal failure.

ABBAD Are you able to give the patient a free diet, avoiding any restriction?

BROYER The diet is always calculated and limited. It could be an advantage of CAPD in being able to give a higher protein intake but conversely, you have a higher protein loss. In young patients we found in chronic patients, not acute patients, an important protein loss with CAPD and not with IPD and this could therefore be a disadvantage.

ABBAD Yes, it could be, but this has to be investigated. I think that the most important advantage of CAPD during the acute phase is that you can give the patients a free diet at a time when they have a poor appetite.

BROYER This may be but it is not always possible to have a good appetite even in CAPD patients.
ABBAD  No, but we think it is a better approach in the acute phase to give a free diet.

BROYER  Have you also more peritonitis with CAPD than with IPD?

ABBAD  Yes, but as I said, the problem we had was that there was leakage from the catheter because in the beginning we used unattached cuffs and since we have not been using that type of catheter we have not had peritonitis or leakage even in our chronic CAPD patients.

SCHARER (Heidelberg)  I would like to support the view of Professor Broyer because I think that most paediatricians until now have used IPD in the acute stage of renal failure mainly because you can overcome the catabolic situation more rapidly. You can therefore stop dialysis earlier in these acute patients. I would like to know if you have had any such results with IPD?

ABBAD  Yes, but not with a permanent catheter.

DONCKERWOLCKE (Utrecht)  It is amazing that you can treat these children in the acute phase of the disease. We have a large experience of acute renal failure in children and most of these children are very ill during the first week or two of the disease and most of them have inadequate feeding, calories and protein intake. I am amazed about the possibilities you have described in this treatment.

KREDIET (Amsterdam)  Could you comment on serum albumin concentrations in your patients.

ABBAD  We have on average an albumin of between 32 and 34g/L during treatment, and only temporarily during peritonitis as low as 22g/L.