Catheter-related complications—including infection, dialysate leak, subcutaneous leak, outflow failure, and malfunction—are the principal causes of peritoneal dialysis (PD) failure. In the present retrospective study, we evaluated the catheter-related complications that occurred in children at our facility who were started on chronic PD during the period from July 1997 to August 2004.

During the study period, 72 catheters were placed in 53 patients (28 girls, 25 boys). The average follow-up period was 29.4 ± 19.3 months. Catheter-related complications developed in 41 patients. The risk for subcutaneous dialysate leak was no more significant when PD catheters were used early (≤7 days post placement) than when use was delayed (>7 days). Similarly, no significant difference was observed in the infection rate between the early- and delayed-use groups. During the study, 87 episodes of peritonitis occurred in 39 patients (1 episode/18 patient–months). The infection rate was significantly different (p < 0.05) in patients with a low serum albumin level. No significant difference was seen between the early- and delayed-use groups in dialysis duration or number of catheter changes. However, we did observe a significant difference (p < 0.05) in subcutaneous leaks with longer dialysis duration. No correlation was observed between early or delayed catheter use and infection, dialysate leak, hernia, or subcutaneous leak.

In conclusion, we observed no significant differences in catheter-related complications between early- and delayed-use catheter groups. A low serum albumin level appears to be a risk factor for infection after PD catheter placement.

Key words
Children, catheter complications

Table 1: Early use and delayed use of catheters by method of catheter placement

<table>
<thead>
<tr>
<th>Method</th>
<th>Early use (≤7 days)</th>
<th>Delayed use (&gt;7 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trocar</td>
<td>16 (30)</td>
<td>11 (20)</td>
</tr>
<tr>
<td>Laparotomy</td>
<td>12 (23)</td>
<td>7 (13)</td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>3 (6)</td>
<td>4 (8)</td>
</tr>
</tbody>
</table>

Introduction
Peritoneal dialysis (PD) in pediatric patients was first introduced in 1978 (1). Chronic PD is widely used for the treatment of patients with end-stage renal disease (ESRD). The advantages of the method are lower cost, simplicity of technique, improved mobility and greater independence for the patient, better control of hypertension, and fewer dietary restrictions (1,2). Three main techniques for catheter insertion have been described: the open surgical technique, the trocar technique, and the laparoscopic technique (3). Complications associated with PD catheters include percutaneous leak, subcutaneous leak, hernia, infection, and malfunction (2,4).

Our aim in the present study was to evaluate catheter-related complications in children started on chronic PD.

Patients and methods
Between July 1997 and August 2004, 53 patients (28 girls, 25 boys) with ESRD were dialyzed by chronic PD. We retrospectively reviewed the patients’ medical records using a standardized data collection form. During the study period, 72 catheters were placed in the 53 patients (Table I). Initial catheter insertion was performed by percutaneous trocar (n = 27), laparotomy (n = 19), and laparoscopy (n = 7). At the beginning of PD, 10 patients received double-cuff Tenckhoff catheters, and 43 patients received double-cuff, swan-neck coiled catheters. In 47 of our patients (88.7%), the catheter exit site was directed downward; in the others, the exit site was directed laterally. All
patients were started on continuous ambulatory PD. During the follow-up period, 14 patients switched to automated PD.

To evaluate catheter-related complications, we divided the catheters into two groups. The “early use” group was defined as a PD catheter used within the first 7 days of placement; the “delayed use” group was defined as a catheter used more than 7 days after placement. The dialysate exchange volumes used by our patients were calculated as 30 – 50 mL/kg.

Complications related to the PD catheter were defined as dialysate leak, catheter malfunction, umbilical hernia, subcutaneous leak, inguinal hernia, cuff protrusion, and peritonitis. Catheter malfunction was defined as incomplete or absent outflow of peritoneal fluid requiring catheter irrigation, manipulation, or removal. An exit-site leak was considered when dialysate moisture was found around the PD catheter. The criteria for peritonitis was cloudy peritoneal fluid and an increased dialysate white cell count (>100 cells/mL) with more than 50% polymorphonuclear cells.

All patients were regularly monitored for biochemical parameters, and dialysate, exit-site, and nasal cultures were performed monthly. Serum concentrations of albumin, total cholesterol, and triglycerides were measured. Body weight, blood pressure, and height were recorded at each clinic visit.

Statistical analysis
All data are presented as mean ± standard deviation. Comparisons of demographic characteristics between the early-use group and delayed-use group were performed using the Fisher exact test. Values of $p < 0.05$ were accepted as significant.

Results
The study included 28 girls (52.8%), 25 boys (47.2%). Their average age at the beginning of dialysis was 11.6 ± 4.4 years (range: 3 days – 19 years). The average duration of PD was 2.6 ± 1.9 year (range: 1 month – 9 years). The average follow-up period after catheter insertion was 29.4 ± 19.3 months (range: 1 month – 104 months).

A total of 72 catheters were placed in the 53 patients. Among the patients, 40 received (75.5%) 1 catheter, 8 (15.1%) received 2 catheters, 4 (7.5%) received 3 catheters, and 1 (1.9%) received 4 catheters. Catheter-related complications developed in 41 patients.

No significant differences in catheter-related complications were observed between the early- and delayed-use groups depending on catheter insertion method. No significant difference was observed the early- and delayed-use groups with regard to the number of catheters inserted.

The major complication during follow-up was peritonitis. During the study, 87 episodes of peritonitis occurred in 39 patients. The overall peritonitis frequency was 1 episode for every 18 patient-months. Of all peritonitis episodes, 43.7% ($n = 38$) were caused by gram-positive bacteria; 26.4% ($n = 23$), by gram-negative bacteria; and 3.4% ($n = 3$), by Candida albicans. Another 26.4% ($n = 23$) of episodes were culture-negative. No tunnel or exit-site infections occurred. No significant differences were observed in the infection rate between patients with early- and delayed-use catheters.

We evaluated the effect of hypoalbuminemia on the catheter complication rate. In our cohort, serum albumin levels at the time of placement ranged from 2.8 g/dL to 4.2 g/dL. In 29 cases (54.7%), albumin was below 3.5 g/dL; in 24 cases (45.3%), it was 3.5 g/dL or higher. We noted a significantly higher infection rate in the patients with low serum albumin ($p < 0.05$).

Other complications related to the catheter (Table II) were umbilical hernia in 8 patients (15.1%), catheter malfunction in 11 patients (20.8%), subcutaneous leak in 18 patients (34.0%), cuff protrusion in 3 patients (5.7%), dialysate leak in 4 patients (7.5%), inguinal hernia in 6 patients (11.3%), hydrothorax in 1 patient (1.9%), and pericardial effusion in 1 patient (1.9%).

The overall rate of subcutaneous leak was 25% ($n = 18$). In 7 of these cases, conservative management did not help the leak to regress, and the catheter had to be replaced. In 6 patients, the catheter was changed once; in 1 patient, the catheter was changed twice. The rate of subcutaneous leak was significantly different between the early- and delayed-use groups ($p < 0.05$).

The overall rate of catheter malfunction was 15.3% ($n = 11$). Conservative management did not solve the problems, and those catheters had to be replaced.

The overall rate of dialysate leak was 5.6% ($n = 4$). In 3 patients, conservative management did not stop the leak, and the catheter had to be replaced. Umbilical hernia developed in 5 patients, and inguinal hernia,
in 6 patients. Those complications were treated surgically. A hydrothorax and pericardial effusion regressed with conservative management. Problems with catheter cuff protrusion occurred in 3 patients. No significant differences were observed between the early- and delayed-use groups for dialysate leak, hernia, or subcutaneous leak.

During the follow-up period, 10 patients died from sepsis or cardiopulmonary complications. Resistant peritonitis or dialysis failure caused the transfer of 7 patients to hemodialysis. Two patients were transferred to another center.

**Discussion and conclusions**

Subcutaneous leak is a noninfectious complication of PD (2,5). In our study, episodes of subcutaneous leakage occurred more often after long-term dialysis, suggesting that dialysis duration is associated with a higher risk of subcutaneous dialysate leak. But, subcutaneous dialysate leakage did not occur when PD catheters were used early (≤7 days after PD initiation) rather than later (>7 days after PD initiation).

A significant number of catheter complications and failures in PD are attributable to catheter malfunction (6). However, in our study, malfunction risk was not different between the early- and delayed-use groups. Patel et al. (7) reported similar findings in their follow-up study of 33 peritoneal catheter placements, comparing delayed with immediate use.

We observed no significant difference in catheter-related complications between early- and delayed-use groups. But a low serum albumin level appears to be a risk factor for infection after PD catheter placement.

The incidence of peritonitis still has a significant impact on the success of chronic PD. Immobilization of the catheter in the postoperative period (at least 3 – 4 weeks) and delayed use of the peritoneal catheter have both been employed to reduce catheter-associated infection (1,8,9). The overall peritonitis rate of 1 episode/18 patient–months in our patients compares with a rate of 1 episode/7.1 – 28.6 patient–months in recent reports (10,11). We found that the peritonitis incidence was higher in the early-use catheter group than in the delayed-use group. However, that higher rate was not statistically significant.

Swan-neck double-cuff catheters and a downward-directed exit site are reported to reduce peritonitis and tunnel and exit-site infections (10). The absence of tunnel or exit-site infections and the low incidence of peritonitis seen in our PD patients may be the result of our use of swan-neck double-cuff catheters and a downward-directed exit site.

Serum albumin is a marker of nutritional status. Low serum albumin is one of the factors predisposing to infection in uremic patients and in those on dialysis (12). In our study, the infection rate was significantly higher in patients with low serum albumin (p < 0.05). That result is similar to the findings of Minnaganti and colleagues (12).

**References**


**TABLE II** Catheter–related complications by early and delayed use of catheters in peritoneal dialysis

<table>
<thead>
<tr>
<th>Complication</th>
<th>Early use (≤7 days)</th>
<th>Delayed use (&gt;7 days)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peritonitis (episodes)</td>
<td>48 (55%)</td>
<td>39 (45%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Subcutaneous leak</td>
<td>9 (16.8%)</td>
<td>9 (16.8%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Catheter malfunction</td>
<td>7 (13.2%)</td>
<td>4 (7.5%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Dialysate leak</td>
<td>2 (3.7%)</td>
<td>2 (3.7%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Umbilical hernia</td>
<td>5 (9.3%)</td>
<td>3 (5.5%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Inguinal hernia</td>
<td>3 (5.6%)</td>
<td>3 (5.6%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Hydrothorax</td>
<td>1 (1.8%)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cuff protrusion</td>
<td>1 (1.8%)</td>
<td>2 (3.7%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Pericardial effusion</td>
<td>—</td>
<td>1 (1.8%)</td>
<td>—</td>
</tr>
</tbody>
</table>

Corresponding author:
Osman Dönmez, MD, Uludag Universitesi Tip Fakültesi, Pediyatrik Nefroloji Bilim Dali, 16059 Görükle, Bursa, Turkey.
E-mail: odonmez@uludag.edu.tr