A Comparison of Two Types of Catheters for Continuous Ambulatory Peritoneal Dialysis (CAPD)

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This study was undertaken to critically examine the value of the curled Tenckhoff catheter for continuous ambulatory peritoneal dialysis (CAPD) access with respect to the incidence of catheter-related complications. In the setting of a prospective, randomised, double-blind comparison, we were unable to demonstrate any advantage of the curled Tenckhoff catheter over the conventional straight type.

KEY WORDS: Curled Tenckhoff catheter; straight Tenckhoff catheter.

Continuous ambulatory peritoneal dialysis (CAPD) is an increasingly popular mode of treatment for end-stage renal failure. While less than 20% of dialysis patients in the United Kingdom were being maintained on CAPD in December 1981 (1), this figure had risen to 41% by December 1986 (2). We have shared a similar experience in our own unit, where in September 1988, 60% of the dialysis population were on CAPD.

Mechanical problems related to the catheters remain an important source of complications in CAPD patients, exceeded in frequency only by peritonitis. One recent development addressing this problem has been the introduction of catheters with curled tips. Anticipated benefits of this new design feature were lessening of abdominal discomfort by decreasing the jet effect of dialysate inflow and a reduction in the incidence of catheter migration (3).

Previous studies comparing different types of catheters have produced conflicting results and have consisted mainly of retrospective analyses (4-8). In view of the lack of a clear consensus of opinion in the literature, we formulated a randomised, prospective, double-blind study to compare curled catheters with conventional straight catheters.

METHODS

Forty consecutive Tenckhoff insertions in 39 patients over an 8-month period between October 27, 1986 and July 1, 1987 at the Western Infirmary in Glasgow were studied. Patients were randomly allocated at the time of surgery to receive either straight or curled catheters, with 20 catheters in each group. Neither the patients nor the staff supervising their care thereafter were aware of the type of catheter used. Patient details are shown in Table 1.

All catheters were double-cuffed Tenckhoffs with 4 cm and 5 cm between cuffs in curled and straight catheters, respectively (Quinton-Kimal Scientific Products, Seattle, WA).

All patients received 1 g of vancomycin by intravenous infusion preoperatively on the day of surgery. Catheters were inserted in the operating theatre using an open surgical technique with general or local anaesthesia. Through a midline or paramedian approach the peritoneum was displayed and a small opening was made in the peritoneum surgically. The catheters were then positioned under direct vision (in case of a curled catheter, with the aid of a wire introducer to straighten out the curled segment) such that the catheter tip lay in the pelvis. The opening in the peritoneum was then closed using a purse-string suture around the catheter. There was no difference between the 2 groups with respect to the surgical approach (Group S: 12 midline/8 paramedian; Group C: 11 midline/9 paramedian incisions).

As part of the study protocol, 2 plain supine abdominal x-rays were obtained in the postoperative period. The first x-ray was within 24 h of insertion and the second was at the nearest outpatient appointment to the third postoperative month. For the second radiographs, patients drained before going to the x-ray department. These x-rays were not made available to the nursing or medical staff looking after the patients and they were reviewed only at the end of the study. Otherwise the usual practice for follow-up remained unchanged. Further x-rays were obtained when a clinical indication arose.

Complications were analysed in 2 main categories: (a) Infective complications: Exit-site, wound, and tunnel infections were defined as isolation of a pathogenic organism on culture in the presence of local signs of inflammation or infection (swelling, redness, pain, or discharge of any nature). In the absence of any clinical signs, isolation of Staphylococcus epidermidis from cultures was not regarded as an infective
complication. Peritonitis was defined as either a positive culture from the dialysis effluent or a white blood cell count > 100/mm³ in the effluent associated with clinical evidence of peritonitis; or (b) Mechanical complications: All other problems in this category were documented in hospital records by nursing or medical staff. Follow-up was terminated at the date of catheter removal or at the last clinic visit before this analysis.

Statistical methods used were Mann Whitney test for the comparison of infective complications and log rank test for catheter survival data.

RESULTS

Comparability of the 2 groups is shown in Table 1. The usual policy of the unit to start CAPD about 10 days after catheter insertion was adhered to except in the following instances. In Group S, 1 patient was transferred to another hospital following catheter insertion. Consequently, 28 days elapsed before an attempt was made to use the catheter. Another patient in Group S had a spontaneous improvement in renal function following catheter insertion, however CAPD had to be commenced 5½ months later and the catheter was used without problems. The remainder of the patients in Group S started CAPD on average on the 11th postoperative day (range 4-19 days). In Group C, 2 catheters had to be removed due to wound infections before commencement of CAPD. The remainder started using the catheter at a mean of 12 days (range 5-16 days) after insertion.

OUTCOME

The outcome in the 2 groups is summarised in Table 2. There were no deaths during the follow-up period. Seven catheters were removed following successful transplantation. At the time of analysis, 3 other patients had received recent transplants and were awaiting catheter removal. Two catheters, both straight tipped, were removed due to reasons other than infection or successful transplantation. One of these was a patient with a hitherto unrecognised diaphragmatic hernia which became manifest by intrathoracic leak of fluid on commencement of CAPD. Despite thoracotomy and repair of the hernia, the leak persisted and CAPD had to be abandoned. The second patient was transferred to another hospital following insertion of the catheter and 28 days elapsed before CAPD was commenced. At this time the catheter was found to be blocked and was removed.

COMPLICATIONS

1. Infective complications. These are summarised in Table 3. The incidence of infective complications did not differ significantly between the 2 groups (see Table 3). A total of 7 catheters were lost predominantly due to infective complications (17.5%), of which 6 were curled and 1 was straight. Two patients had their catheters removed within 2 weeks of insertion, without starting CAPD, due to wound infections. Three patients had peritonitis shortly before elective surgery, in 2 cases before live donor transplantation and 1 before a pelvic floor repair. Other considerations in addition to the peritonitis also influenced the decision to proceed to catheter removal in these cases. Thus, only 2 catheters, 1 in each group, were lost solely due to peritonitis. Exit-site infections were almost exclusively due to Staphylococcus aureus. A wider range of organisms were isolated in episodes of peritonitis although Staphylococcus aureus was again the most common and there were no episodes of fungal peritonitis. All wound and tunnel infections grew a mixed flora.

2. Mechanical complications. These are itemised in Table 4. Two catheters removed for reasons other than infection or successful transplantation (see Table 2) were excluded from the data in Table 4. Patients listed with infusion or drainage problems were documented to have either prolonged (>20 min) and noncontinuous infusion or interrupted and incomplete drainage of CAPD fluid on at least 1 occasion. Four of the routine x-rays on review revealed displaced catheters, 2 from each group. Three of these were seen to be in the left upper and 1 in the right upper quadrant of the abdomen. All 4 of these radiographs...
were routine 3-month postoperative check-up films, thus confirming correct placement at the time of surgery with subsequent migration. Furthermore, none of these 4 episodes of catheter migrations correlated with concomitant catheter malfunction. All 6 patients with infusion or drainage problems had further radiological studies and in 2 of these patients the reason for malfunction was found to be catheter migration. These 2 catheters were repositioned by further surgery. The remaining 2 patients who required further surgery were noted to have intraabdominal adhesions associated with pain on drainage, but no displacement of the catheters.

Overall, 10 patients out of 39 (25%) suffered from a mechanical complication with no significant differences between the groups in this regard. Other noninfective complications included 2 temporary leaks, both in patients with curled catheters, and a total of 6 herniae-2 umbilical, 2 incisional, 1 inguinal, and 1 diaphragmatic-(15%). Both incisional herniae occurred in paramedian incisions. Four of the herniae occurred in Group S and 2 in Group C. Apart from the diaphragmatic hernia none of these complications led to catheter removal.

In a life table analysis (Figure 1), catheter survival remained stable at 90% for straight catheters and 70% for curled catheters after 9 months postinsertion. This difference is not statistically significantly different. In this study, which also incorporated routine radiological investigations, we demonstrated no difference in the tendency to migrate between straight and curled catheters. These findings are in accordance with those of Schleifer et al. (5) and Bierman et al. (9). Apart from the catheter design, such factors as bowel peristalsis and the direction of the subcutaneous

<table>
<thead>
<tr>
<th>Complication</th>
<th>Group S</th>
<th>Group C</th>
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<tbody>
<tr>
<td>Infusion or drainage problems</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Persistent pain</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Migration on x-ray</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Further surgery required</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
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failures. There was another removed due to infective complications and 1 removed due to catheter blockage; both were all included as failures. There was another group of 8 catheters (see Table 2) which were removed following successful transplantation (7) or due to a diaphragmatic hernia (1). These latter events were regarded in the analysis as end of follow-up, but not as catheter failures.

**DISCUSSION**

On theoretical grounds, catheters with curled tips would be expected to migrate out of the pelvis less readily (3) and a reduced incidence of migration has been reported in a few retrospective reviews (4,7). To our knowledge, the curled Tenckhoff catheter has not been assessed by a prospective randomised trial before. In this study, which also incorporated routine radiological investigations, we demonstrated no difference in the tendency to migrate between straight and curled catheters. These findings are in accordance with those of Schleifer et al. (5) and Bierman et al. (9). Apart from the catheter design, such factors as bowel peristalsis and the direction of the subcutaneous

**TABLE 3**

<table>
<thead>
<tr>
<th></th>
<th>Exit-site* infections</th>
<th>Peritonitis**</th>
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<tbody>
<tr>
<td></td>
<td>Number of episodes</td>
<td>Number of patient months per episode</td>
</tr>
<tr>
<td>Group S</td>
<td>266 patient months</td>
<td>21</td>
</tr>
<tr>
<td>Group C</td>
<td>255 patient months</td>
<td>16</td>
</tr>
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* $x^2 = 4.30; p = 0.12$

** $x^2 = 1.76; p = 0.42$
ous tunnel may influence the tendency to migration (5, 10-12) and it may be that these or other factors are of greater importance.

Retrospective analyses are likely to underestimate the incidence of asymptomatic catheter migrations and our findings suggest that they occur more often than is commonly conceived. We have also confirmed previous reports (5) demonstrating that there is not a good correlation between the position of a catheter on x-ray and it's clinical performance. Hence, a radiologically demonstrated catheter migration is not always an indication for surgical intervention. Given this lack of correlation between catheter position and performance, it would seem difficult to justify a policy of routine abdominal x-rays for patients on CAPD as recommended by Rottembourg et al. (4).

Discontinuation of CAPD for a significant period has been documented to result in pressure necrosis and perforation of the abdominal viscera if the dormant catheter is left in situ (13-15). Although we have not encountered this complication, out of the 4 catheters with radiological evidence of migration in our study, 2 had been temporarily out of use following abdominal surgery. It may therefore be speculated that another potential adverse effect of leaving a dormant catheter in situ is to encourage migration.

Peritonitis remains by far the most common complication of CAPD and in this regard we found no difference between straight and curled catheters. Our overall incidence of peritonitis was 1 episode per 17 patient months, a figure which is comparable to the experience of many others (3, 5, 9, 16, 17). However, in our study we did not encounter catheter occlusion from this cause, nor has it been observed more than occasionally by others. Therefore, omentectomy would not seem to be necessary as a routine procedure.

In conclusion, in a prospective randomised study we have been unable to demonstrate any advantage of the curled Tenckhoff catheter over the straight type, which is 30% less expensive. In our view, both catheters provide equally satisfactory access for CAPD.

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