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The Tenckhoff Catheter for Peritoneal Dialysis – An Appraisal

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Abstract. We prospectively evaluated early (within 40 days) catheter complications in all patients receiving a dialysis catheter between 1/8/80 and 1/8/81. 50% of patients achieved a functioning catheter at the first insertion and 24% required replacement of the catheter because of poor dialysate flow. Leaking from the catheter exit site occurred in 20%, infection at the exit site in 9% and peritonitis in 19% of patients. In patients who maintain a catheter over 40 days and undergo treatment by long-term peritoneal dialysis median catheter survival was 400 days with delayed cytheter failure primarily due to failure to resolve a clinical episode of peritonitis. Although the Tenckhoff catheter is readily inserted frequent complications occur.

The permanent peritoneal dialysis catheter first developed by *Palmer* et al. [3] and later modified by *Tenckhoff and Schechter* [1] has been in use for over 15 years [1–3]. The catheter, once placed, provides ready access to the peritoneal cavity and may be used for both acute and chronic dialysis. Several monographs describe techniques for insertion and protocols for management of dialysis catheter-related complications, yet few studies have prospectively addressed the frequency of these complications [4, 5]. For this reason we began a prospective study commencing August 1980 and ending August 1981 wherein we documented the nature of any complication related to the peritoneal dialysis catheter occurring within the first 40 days of placement of the catheter.

Methods

A total of 80 patients were admitted to the study. Among these, 4 underwent peritoneal dialysis for either acute renal failure secondary to acute tubular necrosis or acute glomerulonephritis and 2 others for congestive heart failure. All other patients were deemed to have chronic renal failure.

The Tenckhoff catheters were manufactured by Evermed (Medina, Washington). The intraperitoneal portion was 15 cm from the distal tip of the catheter to Dacron cuff, the last 7 cm being perforated. In one-cuff catheters the cuff is 22 cm from the distal tip. In two-cuff catheters the proximal cuff is 15 cm from the distal tip of the catheter. The distal cuff is 7 cm from the proximal cuff.

All dialysis catheters but one were implanted into patients in the operating theater by the surgical staff. The patients were instructed to void just prior to insertion of the catheter. They were not administered an enema prior to surgery. All but 12 catheters were single cuff. Double-cuff catheters were placed into patients when we were able to plan their entry into continuous ambulatory peritoneal dialysis.

All catheters are placed with 1% Xylocaine infiltration anesthesia. An incision is made in the midline below the umbilicus, and the peritoneum entered by scalpel between hemostats. The catheter is placed in the pelvis either with a long Kelly clamp or with the help of a guide wire. A purse string suture of 000 Dexon is placed around the catheter and secured snugly. The fascia is closed around the catheter with interrupted 000 silk. The catheter is exteriorized through a separate stab incision close to the midline so that the Dacron cuff attached to the catheter is within 2 cm from the exit site. A suture is routinely placed at the exit site. When a two-cuff catheter is placed the proximal cuff is positioned anterior to the peritoneum and the distal cuff positioned subcutaneously as described. Prior to closure the catheters are irrigated to ensure free drainage. The patient is then returned to the ward and dialysis commenced within the hour.

Dialysate exchanges were automated. Either the American Medical Products cycler or Physio-Control PDS-400 were used to deliver dialysate. Dialysate tubing for the cycler was manufactured by American Medical Products. Initially the dialysate infusion volume was 1 liter. A 10-min intraperitoneal residence time was allowed, followed by a 15-min period for dialysate drainage. Sodium heparin, 250 units/l, was used routinely. The initial dialysis lasted 24–48 h. Following this dialysis the volume of instilled dialysate was increased, generally over two subsequent dialyses, so that 2 liters were delivered

to the patient on a schedule of 10 min infusion, 30 min intraperitoneal residence and 15 min for dialysate drainage. All dialysis was supervised by one physician and nurse.

The peritoneal dialysis nurse coordinator kept a record of every peritoneal dialysis catheter placed, the patient's age, sex, race, diagnosis requiring dialysis, and the nature of the dialysis-related complication(s) occurring within 40 days of placement of the dialysis catheter. For purposes of analysis, since there were only 12 double-cuff catheters placed and the complications associated with the two-cuff catheters are similar to one-cuff catheters, we grouped the complications. To determine if patient age, sex, race, weight or diagnosis necessitating dialysis were related to complications associated with dialysis these variables were coded for either the presence or absence of a complication and tested by chi square.

4 patients were initially placed on peritoneal dialysis to treat congestive heart failure, then were either able to be removed from dialysis or were treated by hemodialysis to be returned after an interval of 2 months to peritoneal dialysis. The dialysis catheter had been electively removed in the interim. Since events were so widely separated these catheter insertions were counted twice.

Peritonitis was defined as the presence of abdominal pain associated with a temperature elevation, cloudy dialysate and a positive dialysate culture [6]. Since all these patients had recently undergone surgical placement of a dialysis catheter the presence of pain was not considered sufficient to make the diagnosis of peritonitis.

Leaking from the dialysis catheter insertion site was defined as the presence of fluid at the exit site of the catheter either during or between dialysis.

An exit site infection was diagnosed when purulent drainage was noted at the exit site of the catheter.

We defined catheter obstruction as an inability to infuse dialysate, which occurs when there is a kink in the catheter, or catheter displacement from within the pelvis which is associated with failure to obtain dialysate drainage following infusion.

Results

123 catheters were placed in 80 patients. There were 38 males (26 black, 12 white) and 42 females (30 black, 12 white). Figures 1–3 show the relation of catheter complications and malfunctions to age, weight, and diagnosis. In our series there were significantly more complications and malfunctions associated with patients less than 50 years old ($p < 0.01$). However, race, sex, weight at time of insertion of the catheter, and diagnosis requiring dialysis were not related to complications. In 32 patients (40%), receiving 35 catheters, the catheter functioned without complication on primary insertion. Although complications were noted in 48 patients, these complications only required replacement of the dialysis catheter in 30 patients. Thus 50% of the patients achieved a satisfactorily functioning catheter at the first insertion. The complications that were treated conservatively included 7 obstructions, 7 episodes of peritonitis (1 no bacterial growth on dialysate culture, 2 gram-negative bacterial growths and 4 cultures yielding gram-positive organisms) and 5 episodes of leaking from the catheter exit site.

We were unable to place a dialysis catheter in 2 patients due to the presence of adhesions likely secondary to prior episodes of peritonitis. 1 of these patients had been withdrawn from peritoneal dialysis due to frequent episodes of

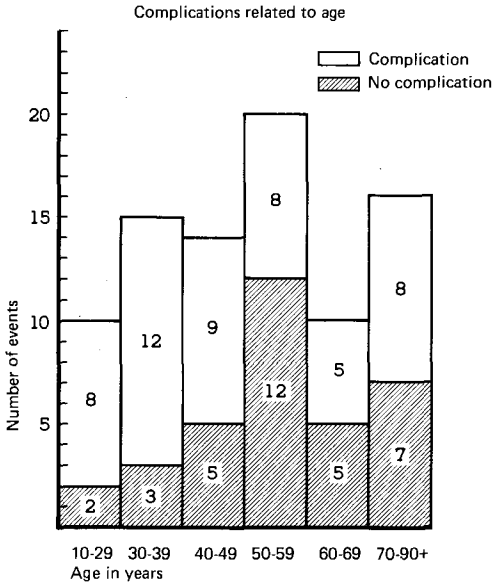

Fig. 1. Frequency of dialysis catheter complications related to patient age at initiation of peritoneal dialysis.

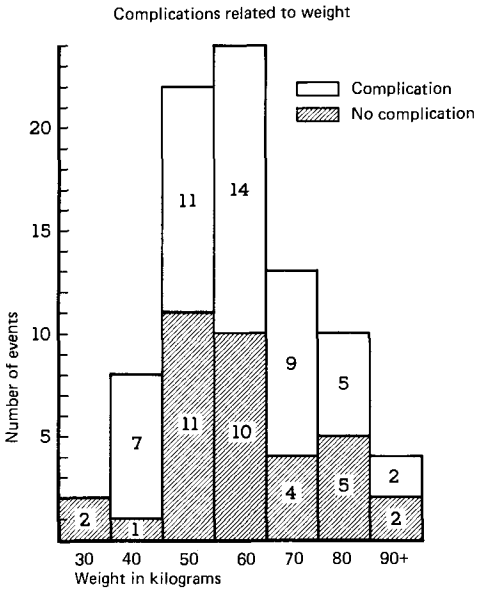

Fig. 2. Frequency of dialysis catheter complications related to weight at initiation of peritoneal dialysis.

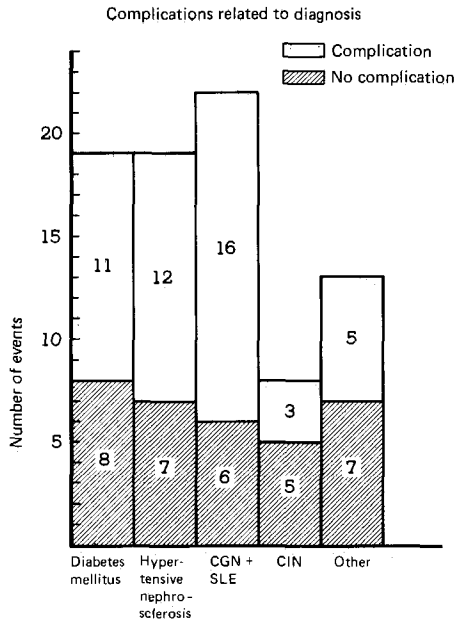

Fig. 3. Frequency of dialysis catheter complications related to etiologic diagnosis of uremia.

peritonitis prior to the start of this study and 1 patient had had the catheter removed because of peritonitis that persisted for a 2-week period. 2 patients had significant bleeding into the peritoneal cavity following insertion of the catheter, associated with a fall in hematocrit and requiring transfusion. The bladder was perforated in 1 instance and in 1 individual an inguinal hernia was not appreciated on physical examination. This hernia acutely enlarged following initiation of dialysis and peritoneal dialysis was terminated.

31 patients had 41 episodes of obstruction or displacement. Of these, 24 were displaced as evidenced by abdominal film or did not resolve following irrigation of the catheter with normal saline and administration of an enema. 10 episodes of displacement resolved following irrigation and enema administration. In 4 episodes the catheter failed to drain even though the catheter was shown to be in the pelvis by x-ray. There were 3 episodes of obstruction that resolved following surgical revision of the catheter, removal of a stitch at the exit site, a hematoma in the subcutaneous tunnel, and a kink in the subcutaneous tunnel of a two-cuff catheter.

Leaking from the catheter insertion site was observed in 16 patients (20%). In 10 patients the dialysate leak was excessive and because of the risk of peritonitis developing, the catheter was removed. The median time to observation of a leak was 3 days (range 1–35 days). 5 of 6 patients in this group who required a second catheter leaked again. In 2 of these individuals the catheters were replaced three times because of excessive leaking. In 1 the leaking resolved itself and in 1 person dialysis was discontinued. 4 of the 6 patients with recurrent leaks with a second dialysis catheter were diabetic. A total of 23 catheters were placed in this group. 5 leaks resolved following the placement of a stitch at the exit site, and 5 resolved spontaneously. A dialysate leak was associated with catheter obstruction in 4 cases. 3 of these 4 cases necessitated removal of the catheter. Peritonitis was associated with a leak in 5 cases but only required catheter removal due to failure to resolve the peritonitis with peritoneal lavage in 1 case. There were 3 episodes of peritonitis with gram-negative organisms, 1 with gram-positive and 1 in which dialysate culture failed to yield organisms.

Exit site infections were noted 8 times in 7 patients (9%) at a median time of 7.5 days (range 1–40) after insertion of the catheter. 4 of these 7 patients were diabetic. All these catheters were single cuff. 2 of 8 infections required catheter removal to adequately treat the infection. 7 of the 8 infections yielded gram-positive cocci and in 1 a gram-negative organism. 2 exit site infections were associated with leaks from the catheter exit site and 5 exit site infections with peritonitis. In 3 cases of peritonitis the causative organism was the same as the organism cultured at the exit site.

Peritonitis occurred 17 times in 15 patients (19%). The catheter was removed in 6 patients because the peritonitis failed to resolve with intraperitoneal antibiotic lavage therapy. The median time to the diagnosis of peritonitis was 6 days after insertion of the catheter (range 1–37 days). 10 of the 17 episodes of peritonitis were associated with a catheter leak, exit site infection or patient disconnection from the dialysate delivery lines. The American Medical Products tubing is not manufactured with a Luer lock between tubing and patient. As mentioned, peritonitis associated with a leaking exit site occurred 5 times. Peritonitis occurred a median time of 1 day after insertion in these cases. 10 of the 17 episodes were associated with gram-negative organisms, 6 with gram-positive (although 1 patient was otherwise asymptomatic) and in 1 case the culture failed to yield bacterial organisms. The occurrence of peritonitis was not associated with any etiologic diagnosis requiring dialysis.

In 11 patients 12 two-cuff dialysis catheters were placed. 1 patient required two catheters because of leaking from the exit site. Four catheters functioned without difficulty. There were 5 instances of obstruction (displacement out of the pelvis) of which 2 resolved. There were 2 episodes of peritonitis (1 caused by a gram-negative, and 1 by a gram-positive organism).

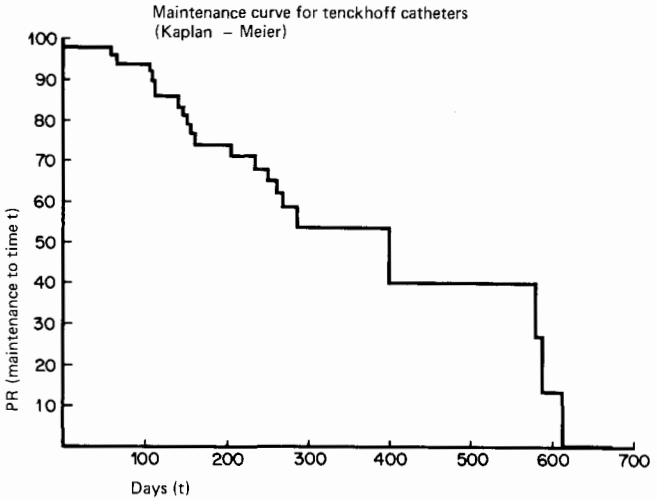

Fig. 4. Time to dialysis catheter failure in catheters lasting more than 40 days.

In patients who were maintained on continuous ambulatory peritoneal dialysis between August 1980 and December 31, 1981 we analyzed long-term catheter function. Patient training for continuous ambulatory peritoneal dialysis was not started until the catheter had been present for at least 2 weeks. We calculated the survival curve of the catheter using the methods of Kaplan and Meir [7]. In these analyses if a patient had been on peritoneal dialysis prior to August 1980 but required a dialysis catheter change, these catheters were included in the analysis. Each catheter was treated as an independent event. Only catheters that had been present over 40 days were included in the analysis. There were 60 catheters with a median survival of 400 days (fig. 4). During this period there were 22 catheter failures: 14 catheters were removed because an episode of peritonitis failed to resolve with therapy. There were 4 late catheter obstructions, failure of outflow in 3 and failure of inflow due to fibrin in 1, 2 cuff extrusions in one-cuff catheters, and 1 catheter exit site and subcutaneous tunnel infection in a two-cuff catheter.

Discussion

This study demonstrates that although insertion of the dialysis catheter may provide quick access for dialysis there are significant problems in the postinsertion period. Our results are not as good as those reported by *Oreopoulos* et al. [4] but similar to those reported by *Valk* et al. [5] suggesting that our experience is not unique (table I). We

Table I. Dialysis catheter complications

	This study	*Oreopolous* et al. [4]	*Valk* et al. [5]
Leakage catheter exit site	20%	14%	14%
Inadequate drainage	38%	13%	39%
Exit site			
Infection	9%	NR	NR
Inflammation	NR	23%	NR
Peritonitis occurring in patients	19%	NR	9%
Severe hemorrhage	2%	NR	2%

NR = Not reported.

Table II. Infections – Incidence in 123 catheter insertions in 80 patients

	n	% of total catheter insertions	Gram +	Gram –	No growth
Exit site infections	8[1]	7	7	1	–
Peritonitis	17	14	6	10	1

[1] Combined exit site infection and peritonitis occurred in 5 of these patients. The organisms were the same in only 9 of these 5 patients.

observed more catheter complications in the younger age-group but cannot attribute a particular cause to this observation. Although no etiologic diagnosis was significantly associated with an increased frequency of complications the results suggest that diabetes mellitus may be associated with increased infectious complications.

The 20% incidence of leaking from the catheter exit site may be associated with our implantation technique. It is possible that a scalpel incision into the peritoneal cavity is longer than the opening required when the trocar method is used. Our data neither support nor contradict this since we were unable to obtain any series reporting the incidence of exit site leaks using the trocar technique.

One suggested approach to prevent leaks is to place the catheter and allow it to remain within the peritoneal cavity unused for 2–3 weeks. Heparinized saline irrigations are performed to prevent fibrin obstruction. This method may be useful for the elective patient as long as blood is not present in the irrigated solution. Another approach is to dialyze patients with smaller intraperitoneal volumes of dialysate (1 liter rather than 2 liters) and prolong the time allowed for dialysate drainage to insure adequate emptying

of the peritoneal cavity. Because of the high incidence of dialysate leaking from the peritoneal cavity we do not commence training for continuous ambulatory peritoneal dialysis until at least 2 weeks have elapsed from the insertion of the catheter.

Exit site infection was an infrequent occurrence. *Tenckhoff and Schechter* [1] have recommended that the sutures not be placed at the skin exit site. Exit site infection may also be related to the technique of exteriorizing the catheter. A stab wound in the skin may gape around the catheter and impair healing. These stitches may have contributed to infection in some instances; however, we feel that stabilization of the catheter thereby preventing tension at the skin exit site is also necessary to prevent exit site infections. An alternate approach might be to stabilize the catheter with tape. Both leaks and exit site infections must be observed closely because of the association with peritonitis. We do not recommend immediate catheter removal as healing may allow sealing of the leaks and local measures are often effective with exit site infections.

Since only 4 patients in this series were on steroid therapy at the time of the peritoneal dialysis catheter insertion, 1 of whom developed recurrent leaking from the exit site, we cannot adequately discuss the risk of concomitant steroid therapy.

The most troublesome occurrence is catheter obstruction since dialysis must be temporarily discontinued. In our population we were not able to demonstrate a relationship between catheter obstruction and patient height. Although we attempt to ensure free flow of the catheter prior to the patient returning from the surgical suite one might consider performing an abdominal x-ray prior to completion of surgery with immediate repositioning if indicated. We do not attempt to manipulate a malpositioned catheter (because we are concerned about potential lapses in sterility and damage to an internal viscus). Since we do not manipulate malpositioned catheters we do not find radiographic positioning of a displaced catheter helpful and do not recommend it. Although we do not know the mechanism by which an enema relieves catheter obstruction, enemas appear to be associated with relief of catheter obstruction. The administration of an enema to patients about to undergo catheter insertion may be considered as a prophylactic measure.

In summary, we find the permanent dialysis catheter useful for repeated peritoneal dialysis. If initial difficulties are overcome the catheter functions without problems, catheter failure being primarily related to complications of peritonitis. Minor catheter problems are frequent and the patients require close monitoring for these complications. Use of the Tenckhoff catheter should be entertained only after the physician and nursing staff are fully cognizant of the potential complications associated with this device.

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