

The permanent Tenckhoff catheter for chronic peritoneal dialysis

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Summary: Over a 3½-year period the permanent Tenckhoff catheter was used in 66 patients (32 men and 34 women) maintained on chronic peritoneal dialysis for periods from 2½ to 36½ months; 57 patients had dialysis in hospital for 20 to 24 hours twice a week and the other 9 had dialysis at home for 10 to 12 hours four times a week. While the Tenckhoff catheter was in place 14 patients received a renal transplant; for 13 who required peritoneal dialysis during the post-transplant phase the Tenckhoff catheter was used. In nine patients abdominal surgery did not interfere with the continuation of peritoneal dialysis via the Tenckhoff catheter.

From a total of 5067 dialyses 40 positive cultures were reported (0.8%). Peritonitis was clinically evident on only 14 occasions (0.28%). Permanent catheter obstruction developed in 16 patients, in 11 of whom it was related to peritonitis.

With the introduction of the permanent Tenckhoff catheter long-term peritoneal dialysis has become a simple, safe and painless procedure, suitable for virtually all patients who require maintenance dialysis.

Résumé: L'utilité du cathéter permanent de Tenckhoff dans la dialyse péritonéale chronique

Depuis 3½ ans nous avons utilisé le cathéter permanent de Tenckhoff chez 66 malades (32 hommes et 34 femmes) soumis à une dialyse péritonéale chronique durant des périodes variant de 2½ à 36½ mois. Chez 57 malades la dialyse était faite à l'hôpital pendant 20 à 24 heures deux fois par semaine; les 9 autres avaient leur dialyse chez eux quatre fois par semaine pendant 10 à 12 heures chaque fois. Alors que le cathéter de Tenckhoff était en place, 14 patients subirent une transplantation rénale; chez 13 de ces malades

qui avaient besoin d'une dialyse péritonéale durant la phase postopératoire, nous avons eu recours au cathéter de Tenckhoff. Chez neuf patients des interventions abdominales n'ont pas empêché la poursuite de la dialyse péritonéale par le cathéter de Tenckhoff.

Sur un total de 5067 dialyses on a signalé 40 cultures positives (0.8%). La péritonite n'a été cliniquement manifeste qu'en 14 occasions (0.28%). Chez 16 patients on a constaté l'obstruction permanente du cathéter; dans 11 cas elle était causée par la péritonite.

Depuis la mise sur le marché du cathéter permanent de Tenckhoff la dialyse péritonéale à long terme est devenue une méthode à la fois simple, sûre et indolore, qui convient virtuellement à tous les malades dont l'état exige une dialyse fréquente.

The permanent Tenckhoff catheter has been one of the main innovations in chronic peritoneal dialysis, comparable in impact to Scribner's shunt for chronic hemodialysis.¹ Since the introduction of this catheter, repeated peritoneal dialysis has become a simple, safe and painless procedure, applicable to virtually all patients requiring chronic dialysis. Furthermore, it has made home peritoneal dialysis possible; many patients previously unsuitable for home hemodialysis can now be trained quickly to carry out the procedure at home.²

Varied results with the Tenckhoff catheter have been reported.³⁻⁶ In this paper we present our experience over a 3½-year period beginning in January 1970.

Patients

Sixty-six patients (32 men and 34 women) were studied; the average age was 40.6 years (range, 11 to 72 years). For 57, peritoneal dialysis was carried out in hospital for 20 to 24 hours twice a week; for the other 9, dialysis was performed at home for 10 to 12 hours overnight four times a week with commercially available dialysate supplied in 1- to 2-l plastic or glass containers. The duration of dialysis averaged 11.2 months (range, 2½ to 36½ months).

Catheter and dialysis procedures

The Tenckhoff peritoneal dialysis catheter (Fig. 1) is made of Silastic Teflon. It is 35 cm long and has two Dacron-felt cuffs, which are bonded to the catheter and divide it into three parts: intra-abdominal, subcutaneous (between the two cuffs; approximately 10 cm long) and external. The intra-abdominal part, 14 to 15 cm long, has numerous spaced perforations of 0.5-mm diameter along the terminal 10 cm. The end of the catheter is open. Through tissue ingrowth into the Dacron the cuffs stabilize the catheter and prevent leakage of dialysate and bacterial invasion along the subcutaneous tunnel. The tissue ingrowth is usually complete within 1 to 2 weeks after implantation. The catheter can be implanted either at the patient's bedside, by means of a special trocar and a technique described by Tenckhoff,⁷ or in the operating room under direct vision.⁴

To ensure catheter patency, dialysis is begun immediately after implantation, in 1-l exchanges without any "dwell" time; heparin, 500 units/l, is added to each exchange. Dialysis is continued for a minimum of 2 days.

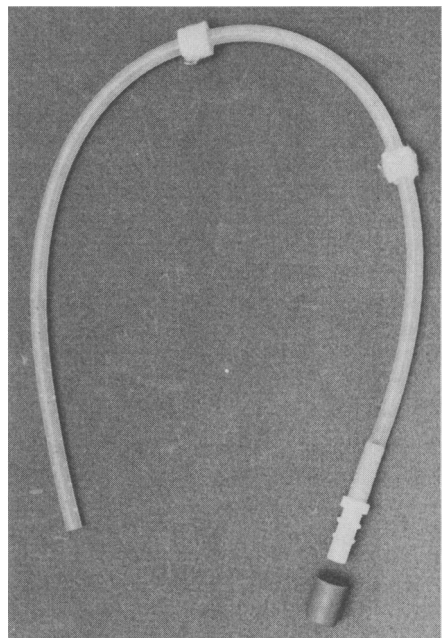


FIG. 1—Tenckhoff peritoneal catheter.

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When the catheter is functioning satisfactorily, 2-1 exchanges are given with a dwell time of 20 minutes. Samples of ascitic fluid are taken daily at the beginning of each dialysis for culture. At the end of dialysis 3 ml of heparin (1000 units/ml) is instilled into the catheter and the open end is sealed with a special plug or a rubber cap (Fig. 1). After it has been cleansed with alcoholic solution of chlorhexidine (Hibitane) diacetate (1:200) the catheter is wrapped in sterile gauze and covered with a sterile, waterproof dressing (Airstrip), which enables the patient to bathe, shower or swim between dialyses. To begin the next dialysis the patient connects the catheter to the dialysate administration tubing under strict sterile conditions. A sample of the ascitic fluid or the first effluent is always sent for culture. For the first 2 months after catheter implantation heparin is added to the dialysate, and thereafter only to the dialysate of patients who tend to have fibrin clots.

Results

A total of 78 catheters were implanted; five patients had a second, two a third and one a fourth catheter.

From the 5067 dialyses performed, 40 positive cultures of ascitic fluid or first effluent were obtained (0.8%); the organisms isolated are listed in Table I.

Complications

Peritonitis: Clinical peritonitis, manifested by abdominal pain, rebound tenderness, pyrexia, cloudy effluent and a positive culture, occurred in 14 patients (0.28% of the dialyses); the organisms isolated are shown in Table II. When peritonitis developed, the average duration of dialysis was 7.8 months (range, 1 to 16 months). Of the 14 patients, all but 1 was treated successfully by methods that have been described previously.⁸ One patient, cared for early in this study, died of persistent peritonitis that failed to respond to treatment; multiple tunnel abscesses along the catheter tract were noted at autopsy.

Peritonitis resulted in permanent catheter obstruction in 11 patients; in 7, peritoneal dialysis was continued with the Deane prosthesis until all signs of infection had cleared, at which time the Tenckhoff catheter was reimplanted.⁹

Mechanical problems: Two patients extruded the distal Dacron-felt cuff (outside the tunnel) onto the skin, probably because the cuff was placed too close to the exit from the skin. We now ensure that this cuff is placed 1 to 2 cm below the exit. Whenever the cuff extrudes, the subcutaneous tunnel is susceptible to infection and usually

the catheter must be removed.

Two patients sustained bowel perforation during implantation of the catheter with the Tenckhoff trocar. Since we began introducing the catheters under direct vision in the operating room there have been no further perforations.

In two patients abdominal pain related to the inflow of fluid occurred some time after implantation; the pain was in the right hypochondrium in one and in the left hypochondrium in the other. Radiologic examination of the catheter after introduction of contrast material into it disclosed that the tip had been misplaced towards the liver in the first patient and the spleen in the second. Both catheters had to be removed.

Dialysate leaked out around the skin exit in three patients, usually through a large incision in the peritoneum and the abdominal wall. This was successfully managed by withholding dialysis for 7 to 10 days, until sufficient connective tissue had formed around the Dacron cuffs.

Nine patients had "one-way" obstruction; that is, the dialysate would flow freely into the peritoneal cavity but would not drain out. This complication was successfully overcome in four patients by stimulating vigorous bowel peristalsis with laxatives or enemas. In the other five patients the obstruction became permanent and the catheter was removed. Because this complication may be due to "wrapping" of the catheter with omentum and the creation of a valve mechanism, we resected the omentum in three patients who had recurrent one-way catheter obstruction and secured adequate catheter function.

Tunnel abscess: This occurred in two patients and necessitated removal of the catheters.

Bloody effluent: In four patients the first effluent was persistently blood-stained, probably because small adhesions ruptured during the first ex-

change. This never necessitated removal of the catheter.

Pain of undetermined cause: During the first few weeks after catheter implantation two patients complained of severe pain — in the rectal area in one and in the suprapubic area in the other; the pain disappeared after 4 weeks without any specific treatment.

Abdominal operations and transplantation

Nine patients underwent abdominal operations while the Tenckhoff catheter was in place, without interference with the continuation of peritoneal dialysis. Fourteen other patients received a kidney transplant; 13 required peritoneal dialysis after transplantation, and this was carried out satisfactorily with the Tenckhoff catheter. The kidney was permanently rejected in four patients and chronic peritoneal dialysis was resumed by means of the original Tenckhoff catheter.

"Survival" of Tenckhoff catheters

In 16 patients the catheter became permanently obstructed after an average of 5.8 months (range, 2 weeks to 14 months). In 11, the obstruction was related to peritonitis. In the other five, permanent obstruction followed a period of one-way obstruction that did not respond to stimulation of intestinal peristalsis with laxatives. Only 1 of the 16 patients had a positive dialysate culture without other evidence of peritonitis before obstruction.

Thirty-seven catheters were still functioning when dialysis was discontinued because of either renal transplantation or the patient's death. The average "survival" rate of the catheter was 7 months (range, 2 weeks to 27 months). Twenty-five catheters were still functioning after an average of 11.2 months (range, 2½ to 36½ months).

Discussion

The main disadvantage of the temporary peritoneal catheter is that a new catheter has to be inserted through

Table I—Organisms isolated from ascitic fluid of patients without other evidence of peritonitis

Organism	No. of isolates
<i>Staphylococcus pyogenes</i>	13
<i>Streptococcus viridans</i>	10
<i>Pseudomonas aeruginosa</i>	4
<i>Klebsiella aerogenes</i>	3
<i>Acinetobacter anitratus</i>	3
<i>Enterobacter aerogenes</i>	1
Diphtheroid bacilli	1
<i>Escherichia coli</i>	1
Micrococci	1
Enterococci	1
<i>Candida krusei</i>	1
Hemolytic streptococcus	1
Total	40

Table II—Organisms isolated from patients with clinical peritonitis

Organism	No. of isolates
Staphylococci	4
<i>Acinetobacter anitratus</i>	3
<i>Klebsiella</i> sp.	2
Micrococci	1
<i>Streptococcus viridans</i>	1
<i>Pseudomonas aeruginosa</i>	1
Enterococci	1
Gram-negative cocci (unidentified)	1
Total	14

a new abdominal hole or through the fistulous tract maintained by the Deane prosthesis each time dialysis is necessary. This is traumatic for the patient, necessitates the service of medical personnel and increases the risk of infection. As a result, chronic peritoneal dialysis with the temporary catheter is almost impossible except, perhaps, when the Deane prosthesis is used.⁹ The Tenckhoff catheter, however, may be permanently implanted in the abdominal wall, thus providing painless and safe access to the peritoneal cavity and making chronic peritoneal dialysis possible.

Perhaps the only disadvantage of the Tenckhoff catheter is that, in case of failure, its removal is a little more difficult than that of the temporary catheter. However, because failure is infrequent, this is a minor disadvantage.

Although the permanent catheter can be implanted at the bedside, we found it safer and more convenient to implant it in the operating room under direct vision. There were two episodes of bowel perforation while the catheter was being implanted at the bedside with the special trocar, but none since we started implanting it under direct vision.

A frequent complication is one-way obstruction of the catheter. In most patients this is related to constipation and the obstruction resolves after vigorous bowel peristalsis is induced with enemas or laxatives.⁵ In some, however, the obstruction becomes permanent. Radiologic examination of the catheter rarely shows obstruction of the lumen. Obstruction may also be due to "wrapping" of the catheter with omentum or misplacement of the catheter under the anterior abdominal wall or under the diaphragm. The latter situation can be detected easily by radiography⁵ and the remedy is relocation or replacement of the catheter. However, many catheters that become misplaced still function well.

A modification of the Tenckhoff catheter, introduced by Goldberg and Hill,¹⁰ may avoid entirely misplacement of the catheter and interference with its function by the omentum: a balloon attached to the middle of the intra-abdominal part of the catheter can be inflated with 20 ml of saline to keep the omentum away from the catheter and hold the catheter down in the pelvis. Because of these features it is expected to function longer than the original Tenckhoff catheter. The main disadvantage of the Goldberg catheter is that a second tube at its distal end is required to inflate the balloon. This necessitates a larger skin exit for the catheter, which increases the risk of

leakage of dialysate around the catheter. However, because no one has extensive experience with the new catheter, it is premature to draw conclusions and make comparisons between the two catheters.

Clinical peritonitis was the cause of catheter obstruction in most instances in our series (11 of 16), as in others.¹¹ To treat the peritonitis we did not find it necessary to remove the catheter in the presence of active infection, especially if the catheter was patent. Instead, we continued dialysis, adding antibiotics to the dialysate. If the permanent catheter was obstructed we continued dialysis with a temporary catheter until all signs of infection had subsided, then replaced the permanent catheter. This policy has helped us avoid temporary hemodialysis treatment during episodes of peritonitis. We could not confirm the observation of others^{2,3} that low-grade, asymptomatic infection with positive cultures of the ascitic fluid usually precedes permanent catheter obstruction.

Prophylactic therapy with antibiotics in the dialysate seems to be unnecessary in view of the low incidence of peritonitis (0.28%) in our program without their use. That strict aseptic technique is the most important factor in prevention of peritonitis⁵ is implied by the even lower incidence of peritonitis (0.1%) among our patients conducting peritoneal dialysis at home. Since nurses perform most of the dialysis procedures in hospital, a permanent, well trained nursing staff is the key to the success of a hospital peritoneal dialysis program.

Tunnel abscesses usually occur when the cuff lies near the skin exit and is extruded, or in patients who are chronic carriers of staphylococci on the skin.² Formation of tunnel abscess is an indication for catheter removal. Failure to remove the catheter seems to have contributed to the development of resistant peritonitis and death in one of our patients.

Adding heparin to the dialysate and instilling it into the catheter between dialyses seems to prevent catheter obstruction.^{3,4,6,12} We add heparin to the dialysate during the first 2 months after catheter implantation and then only for those patients in whom fibrin clots tend to develop — as they did in approximately one third of the patients — because some of these clots may cause permanent catheter obstruction if their production is allowed to continue. Heparin prevents further fibrin clot formation.

Except for those who have received a kidney transplant, we usually avoid peritoneal dialysis in patients who have

had a recent abdominal operation; instead we prefer to use hemodialysis for 2 to 3 weeks after the operation. However, the patients for whom peritoneal dialysis was necessary immediately after an abdominal operation had an uneventful course. Like others,^{4-6,11} we used peritoneal dialysis in the post-transplant period. Peritonitis developed in only one patient and was successfully treated.

We believe the permanent Tenckhoff catheter is one of the most important developments in peritoneal dialysis. Its many advantages have made chronic peritoneal dialysis in hospital or at home simple and safe. Since most cases of catheter obstruction were related to peritonitis, strict adherence to sterile techniques should result in longer catheter survival.

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