Laparoscopic Implantation of the Tenckhoff Catheter for the Treatment of End-Stage Renal Failure and Congestive Heart Failure: Experience with the Pelvic Fixation Technique

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Abstract

Background: Peritoneal dialysis is a widely accepted route for renal replacement. With the advent of endoscopy, many surgical techniques for the prevention of catheter failure have been proposed.

Objectives: To evaluate the outcomes of patients undergoing laparoscopic Tenckhoff catheter implantation using the pelvic fixation technique.

Methods: Data analysis was retrospective. All procedures were performed under general anesthesia. A double-cuffed catheter was inserted using two 5 mm trocars and one 10 mm trocar, fixing its internal tip to the dome of the bladder and its inner cuff to the fascia. Catheter failure was defined as persistent peritonitis/exit-site/tunnel infection, severe dialysate leak, migration or outflow obstruction.

Results: LTCI was performed in 34 patients. Mean patient age was 65 ± 17 years. In 12 of the 34 patients the indication for LTCI was end-stage renal failure combined with NYHA class IV congestive heart failure. Operative time was 35 ± 15 minutes. A previous laparotomy was performed in 9 patients. Hospital stay was 1.5 ± 0.6 days. The first continuous ambulatory peritoneal dialysis was performed after 20 ± 12 days. Median follow-up time was 13 months. There were several complications, including 5 (14%) exit-site/tunnel infections, 27 episodes (0.05 per patient-month) of bacterial peritonitis, 3 (9%) incisional hernias, 1 case of fatal intraabdominal bleeding, 2 (5.8%) catheter migrations (functionally significant), and 10 (30%) cases of catheter plugging, 8 of which were treated successfully by instillation of urokinase and 2 surgically. A complication-mandated surgery was performed in 8 patients (23.5%). The 1 year failure-free rate of the catheter was 80.8%. One fatal intraabdominal bleeding was recorded.

Conclusions: LTCI is safe, obviating the need for laparotomy in high risk patients. Catheter fixation to the bladder may prevent common mechanical failures.

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Peritoneal dialysis is used by over 100,000 end-stage renal disease patients worldwide, accounting for approximately 15% of the dialysis population [1]. The relative value of PD is still uncertain and contested due to a lack of randomized clinical trials comparing dialysis modalities. However, clinical experience with PD suggests that it is a useful early therapy in ESRD and is a necessary third modality to complement hemodialysis and transplantation. As early as 1949, PD was also proposed for the treatment of severe congestive heart failure [2]. Further encouraging results were recorded later, both with intermittent peritoneal dialysis and with continuous ambulatory peritoneal dialysis [3,4]. A recent literature review counted 115 published case reports, which gathered patients with congestive heart failure, either isolated or associated with chronic renal failure, proving the efficacy of this therapeutic tool [5].

Until the early 1990s virtually all implantations of Tenckhoff catheters were performed through an open laparotomy. However, the advent of endoscopic surgery did not discard this procedure, and in recent years this task is carried out laparoscopically, thus obviating the need for laparotomy in these high risk patients. This series describes both short- and long-term outcome of patients undergoing laparoscopic Tenckhoff catheter implantation using the pelvic fixation technique. This is the first report to elucidate the consequences of this technique in CHF patients.

Patients and Methods

The procedure

The Tenckhoff catheter (Coiled Peritoneal Silicone Catheter, double cuffed, 56.5 cm, 14.7 FR; Horizon Medical Products®, Manchester, GA, USA) was used for all procedures. All patients received 1 g cefazolin sodium intravenously prior to surgery as prophylaxis. The catheters were implanted in the operating room by senior surgical residents under the supervision of one attending surgeon. All procedures were performed under general anesthesia. Pneumoperitoneum was obtained by CO_2 insufflation to a pressure of 12 mmHg. A 10 mm trocar was inserted in the midline, 3 cm above the umbilicus. Two additional 5 mm trocars were positioned 5–7 cm lateral to the umbilicus, on each side. A 10 mm, 30° laparoscope was inserted, and the peritoneal cavity was explored, lysing potentially interfering adhesions. The Tenckhoff catheter was introduced through the 10 mm trocar, and its internal tip was fixed to the dome of the urinary bladder

LTCI = laparoscopic Tenckhoff catheter implantation
PD = peritoneal dialysis

ESRD = end-stage renal disease
CHF = congestive heart failure

by a 3/0 ETHIBOND™ suture (Ethicon Inc. Johnson & Johnson, NJ, USA). The proximal end was brought out to arise from the supra-umbilical port, and the inner cuff was fixed to the underlying fascia using a 3/0 Vicryl suture (Ethicon Inc.). The remaining proximal catheter was placed in subcutaneous tunnel, and was exteriorized 4 cm to the left of the 10 mm trocar site. The outer cuff was not sutured.

Postoperative care

Vital signs were monitored every 4 hours in the first 24 hours after surgery. The regular medical treatment was resumed, and the patients were evaluated for evidence of pulmonary congestion, acid-base abnormalities or hyperkalemia. All patients were encouraged to resume oral intake as soon as possible. Not longer than 1 week after discharge, all patients underwent a physical examination in the CAPD clinic, focusing on catheter patency, exit-site infection and signs of peritonitis. A rapid in-and-out exchange was performed. A plain X-ray of the abdomen was done to ascertain the catheter's position in the pelvis. The patient was scheduled for the first cycle of PD. Further CAPD cycles were performed as scheduled by the attending nephrologists, according to the patient's status. Peritoneal fluid cultures were taken every 14 days, and the patient treated accordingly. The diagnosis of peritonitis was made on the basis of at least two of the following [6]: a) abdominal pain or cloudy peritoneal dialysis effluent, b) leukocytosis in the peritoneal dialysis effluent (white blood cell count >100/ml), and c) positive Gram-stain or culture from peritoneal dialysate effluent. In cases of catheter blockage, three trials of intra-catheter instillation of urokinase were performed. Catheter failure was defined as persistent peritonitis, exit-site/tunnel infection refractory to antibiotic treatment, persistent dialysate leak, or outflow obstruction unamenable to conservative treatment.

Data collection

All patients were followed in our hospital CAPD clinic. Demographic, medical, operative, postoperative and other information regarding complications and continued patient management was obtained retrospectively from the patients' medical records and entered into a computerized database. Follow-up time was defined as from the day of LTCI to December 2004, patient's death or date of catheter permanent removal. Data are presented as percentages, mean ± SD or median, as appropriate. The Kaplan-Meier curve was used for plotting catheter survival. Data were processed by Microsoft® Excel 2002 for Windows, and analyzed by BMDP Statistical Software®.

Results

Thirty-four patients (22 males, 64.7%) were enrolled in the study, all of whom underwent LTCI between January 2001 and October 2004. Patients' ages ranged between 21 and 86 years (mean 65 ± 17.5). In 22 patients (64.7%) chronic renal failure was the indication for LTCI. New York Heart Association class IV CHF (inability to carry out any physical activity without discomfort, and symptoms of cardiac insufficiency at rest) combined with chronic renal insufficiency were the indication for LTCI in the remainder (12/34, 35.3%). The severity of renal and cardiac dysfunction as well as other co-morbid states is presented in Table 1. Nine (26.5%) patients underwent a midline lower abdominal laparotomy prior to LTCI for other reasons.

Mean operative time was 35 ± 15 minutes (10–65 minutes). None of the procedures was converted to an open laparotomy. No intraoperative deaths were recorded. Mean hospital stay after surgery was 1.5 ± 0.6 days (1–3 days). Postoperative pain was controlled by parenteral opiate analgesics in 3 of the 34 patients (14.7%). Mean time to first PD using the implanted catheter was 20 ± 12 days (range 5–60). A non-fatal myocardial infarction was diagnosed postoperatively in one patient. No deterioration in congestive heart failure status, myocardial ischemia or new arrhythmia was recorded during the 2 weeks following surgery. Median follow-up time in the CAPD clinic after LTCI was 13 months (1–44 months).

The postoperative complications (either catheter- or procedure-related), their timing, and rates of surgical interventions are listed in Table 2. All three hernias were located in the 10 mm trocar

CAPD = continuous ambulatory peritoneal dialysis

Table 1. Characteristics of the study group

	CRF (n=22)	CRF & CHF (n=12)	Total (n=34)
Creatinine clearance*	14.2 ± 5.5	18.2 ± 8.7	15.6 ± 7.0
Left ventricular ejection fraction**	–	34.5 ± 5.2	–
Chronic obstructive pulmonary disease	7 (32%)	5 (42%)	12 (35%)
Diabetes mellitus	16 (72%)	9 (75%)	25 (73%)

* In ml/min/1.73 m^2, obtained 1 month prior to LTCI

** As measured by echocardiography, only in CHF/CRF patients (%)

Table 2. Complications of catheter insertion

	Incidence	Median time of appearance (days postoperatively)	Surgical intervention†
Exit-site/tunnel infection	5/34	10	0/5
Range	(14.7%)	6–20	
Incisional hernia	3/34	120	1/3
Range	(8.8%)	90–150	(33%)
Peritonitis*	0.05	50	3/16
Range		10–330 (1st episode)	(18.7%)
Migration**	2/34	25	2/2
Range	(5.8%)	20–30	(100%)
Outflow obstruction	10/34	30	1/10
Range	(29.4%)	15–70	(10%)
Pericatheter leak	1/34	20	1/1 (100%)
Total (per patient)	49 (1.4)	–	8/34 (23.5%)

* Mean number of episodes per patient-month. Total of 27 cases in 16 patients.

** Leading to malfunction.

† Catheter replacement/repositioning/removal or hernia repair.

site. Overall, a postoperative complication mandated surgical intervention in eight patients (23.5%) (2 cases of catheter replacement, 2 repositionings, 3 removals and one incisional hernia repair). Only one hernia (out of three) was repaired because the other two patients sustained further cardiac deterioration and the defect was relatively small. Dialysate outflow obstruction was treated successfully by instillation of urokinase in 8 of 10 cases. In the remaining two, laparoscopy was performed, disclosing peritoneal adhesions in one case (catheter was repositioned) and omental wrapping in the other (catheter was replaced). Except for catheter removal or external repositioning, all of the complications were managed laparoscopically.

Failure-free survival rates with the Tenckhoff catheter are shown in Figure 1. In nine patients (26.4%) the catheter was removed permanently. Five of these patients (4 CRF, 1 CHF/CRF) were switched to hemodialysis, and the remaining four (CHF patients) continued medical treatment. Catheter failure was responsible for removal of the implant in three cases, all of which were due to persistent *Staphylococcus aureus* peritonitis. The rest of the removals were performed due to failure of the treatment modality (four cases), patient's choice to stop PD (one case) and a successful kidney transplantation (one case). Procedure-related mortality was recorded in one case. The patient was treated with warfarin, which was switched to enoxaparin 72 hours before surgery, with complete normalization of prothrombin and activated partial thromboplastin times. Inadvertently, oral anticoagulation was resumed immediately after surgery and he exanguinated in the internal medicine department on the sixth postoperative day. Unfortunately, an autopsy was not performed.

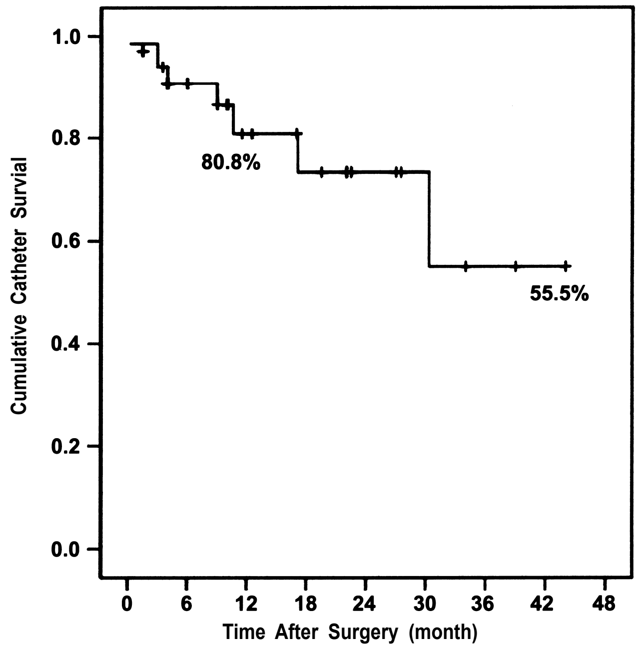

Figure 1. Kaplan-Meier plot* of catheter survival after LTCI. Catheter 'death' refers to procedure-related mortality or to cases of catheter failure treated by replacement or removal of the implant.

* Events are defined as catheter failures obligating permanent removal or replacement of implant (repositionings were not included).

Discussion

Peritoneal dialysis is widely used for the treatment of patients with end-stage renal disease with or without congestive heart failure. However, complications related to the PD catheter have diminished the success of this renal replacement route. The ideal method for implantation of CAPD catheters has been a subject of debate in the past few decades. Until a few years ago, the most commonly used technique was an open surgical approach, using a 'minilaparotomy' incision [7]. Others have used a 'blind', wire-guided approach, but this method did not gain popularity due to an unacceptable rate of visceral injury [7]. Laparoscopic implantation of CAPD catheters has expanded in recent years largely because of the introduction of the laparoscopic technique, which allows direct visualization of the peritoneal cavity and presumably leads to better positioning of the catheter [7–9]. The present study shows the feasibility of the procedure, the relatively low rates of complications and failures, and its safety among high risk patients.

As reflected by some of our data, the advantages of the laparoscopic approach include diminished postoperative pain, better cosmesis, shorter hospital stay and faster return to social activities. For comparison, studying 21 patients who underwent open Tenckhoff catheter implantation, Öğünç et al. [9] report a mean hospital stay of 3.1 days. Wound healing mechanisms are markedly impaired in uremic patients [10]; this phenomenon is further aggravated in diabetics [11], who comprised a large proportion of our cohort (75%). Hence, creating fewer tissue disturbances, laparoscopy appears to be superior to open surgery in this sense. Lu and colleagues [12] report a 7% rate of port-site hernias after LTCI. This finding is supported by the relatively low rate of incisional hernias (8.8%) in the present study group, compared to higher rates (up to 30%) reported with open techniques [7].

Due to the ability to perform most of the open procedures for PD catheter implantation under local anesthesia, the disadvantages of LTCI include mainly the need for general anesthesia and the adverse effects of CO_2 pneumoperitoneum [13,14]. However, more than a third of our cohort patients had either severe CHF or chronic obstructive lung disease, but none of them sustained any notable deterioration in the immediate postoperative period. Although our work is retrospective, it should be noted that none of the patients who were assigned to CAPD treatment in the past 4 years was rejected from laparoscopy due to the severity of cardiopulmonary disease. Thus, despite the adverse effects of general anesthesia and pneumoperitoneum on cardiovascular and pulmonary stability, a thorough medical control of these high risk patients should be achieved preoperatively.

It appears that as endoscopic techniques as well as surgical skills develop, intraperitoneal adhesions are no longer an obstacle for laparoscopy. Indeed, more than one-fourth of our

CRF = chronic renal failure

patients and more than 50% of those described by Öğünç et al. [9] underwent an open lower abdominal surgery prior to LTCI. None had to be converted to open laparotomy in order to implant the PD catheter [9]. Moreover, LTCI is advantageous in terms of the ability to perform other surgical procedures such as cholecystectomy, hernia repair or liver biopsy in the same session [9].

Catheter-related complications can be classified as infectious or mechanical. Both exit-site and tunnel infections have been shown to be less frequent after LTCI than after open surgery [15]. Although the definitions of such superficial infections may differ between series, our 14.7% incidence is comparable to the data reported by Öğünç et al. (19%) [9]. Peritonitis is a major complication of PD. The introduction of the various disconnect systems have eliminated mainly the mild peritonitides, whereas the serious episodes (*Staphylococcus aureus*, Pseudomonas spp. and fungi) still remain a major problem. The etiology of peritonitis in PD patients is diverse, including skin and nasal carriage of certain microbes, diabetes, previous antimicrobial treatment, the presence of exit-site infection, etc. [16]. Moreover, previous series did not employ uniform definitions of peritonitis, and some of them ignored the known entity of *culture-negative peritonitis* [10,16]. Hence, although acceptable, the rate of 0.05 episodes per patient-month reported in the present series should not be compared to the data in the literature.

The most frequent mechanical complications of LTCI are catheter migration, outflow obstruction and pericatheter leak. As the violation of the abdominal wall integrity is minor in laparoscopic surgery, the incidence of the latter declined sharply from 6–32% in series describing open procedures for Tenckhoff catheter implantation [15,17] to negligible numbers [9,12]. Poor drainage of dialysate fluid usually results from malplacement of the catheter at operation, omental wrapping, catheter migration out of the pelvis, or adhesions. These problems may lead to malfunction immediately to several months after implantation [18,19]. Some authors have addressed the issue of prevention of catheter migration. Currently the only effective technique is catheter suture fixation to the pelvis [12,15]. Indeed, only 2 of our 34 patients were diagnosed as functional failure due to catheter migration. Both cases were managed laparoscopically, by resuturing the catheter to the pelvis, resulting in perfect function. Although the published number of patients treated by this approach is limited, no case of injury to the urinary bladder has been reported thus far. Catheter outflow failure followed open surgical and blind guide-wire/trocar methods of implantation in 4–34.5% of patients [19]. Unfortunately, outflow obstruction is found in up to 60% of patients in some series [20]. Many authors have attributed this obstacle to omental wrapping around the fenestrated part of the catheter responsible for fluid exchange [12,20]. As a solution, laparoscopic procedures such as omental fixation or omentectomy during catheter implantation have been advocated [9]. In the presented series, only two patients underwent surgery owing to outflow obstruction. Only one case was attributable to omental blockage. Indeed, appropriate fixation of the catheter to the pelvis appears to minimize the risk for such a complication. However, suturing the catheter tip to the pelvis creates a potential site for internal hernia, adhesions to the tack-up site, and the suture knot serving as a nidus of persistent infection following dialysis-related peritonitis [21,22].

Conclusion

The laparoscopic procedure itself is safe and tolerable in high risk patients suffering from end-stage renal and cardiac diseases. Causing less tissue damage and performed under vision using fixation techniques, LTCI appears to be superior to the open or blind procedures in terms of mechanical complications. The procedure is therefore advocated for the establishment of a renal replacement route. In addition, the laparoscopic approach allows diagnosis and treatment of accompanying surgical pathologies during the same operation.

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