Complications of Tenckhoff Catheter Insertion Via Rectus Muscle-Splitting Technique: Six-Year Experience and Review of the Literature

REKTUS KASI ARALANARAK TENCKHOFF KATETERİ YERLEŞTİRİLMESİ TEKNİĞİNİN KOMPLİKASYONLARI: 6 YILLIK DENEYİM VE LİTERATÜR İNCELEMESİ

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Abstract

Objective: The purpose of our study was to determine the complications of Tenckhoff catheter insertion via rectus muscle-splitting technique and compare the advantages and disadvantages of this technique with a review of the literature.

Material and Methods: The surgical complications pertaining to 106 continuous ambulatory peritoneal dialysis catheters were reviewed in 100 patients from June 1997 through December 2003. All catheters were inserted in the operating room by an open technique. Local anaesthesia was used in all patients. The peritoneal cavity approach was performed via an infraumbilical paramedian muscle-splitting incision for all placements. The complications were classified as intraoperative or postoperative.

Results: Intraoperative complications consisted of 1 urinary bladder placement, 6 early leakages, 4 wound infections, 3 exit site infections, 3 peritonitidis and 2 rectus muscle haematomas. Peritonitis was the most frequent postoperative complication; there were 54 cases of peritonitis in 2930 patient months (1 episode per 54.3 patient months). Other postoperative complications were 35 exit site infections in 23 patients (1 case per 83.7 patient months), 4 outflow obstructions, 1 inguinal hernia, 6 late leakages and 7 umbilical hernias.

Conclusion: In the study, the rate of peritonitis, major complication, dialysate leakage, exit site infection, incisional and inguinal hernia was comparable to or lower than in other series. Meticulous surgical technique and infraumbilical paramedian muscle-splitting approach in catheter placement provided low complication rates. Consequently, the average catheter life was higher than in most studies (29.3 months).

Key Words: Peritoneal dialysis; complications; diagnostic techniques, surgical; kidney failure

Özet

Amaç: Çalışmamızın amacı rektus kası aralanarak Tenckhoff kateteri yerleştirilmesi tekniğinin komplikasyonlarının ortaya konması ve bu tekniğin avantajları ve dezavantajlarının literatür verileriyle karşılaştırılmasıdır.

Gereç ve Yöntemler: Haziran 1997 ile Aralık 2003 tarihleri arasında, 100 hastaya yerleştirilmiş 106 periton diyaliz kateterine ait komplikasyonlar incelenmiştir. Tüm kateterler ameliyathanede açık teknikle yerleştirilmiştir. Tüm kateter uygulamalarında lokal anestezi kullanılmıştır. Periton boşluğuna göbek altı paramedian -rektus kası aralanarak- insizyon ile ulaşıldı. Komplikasyonlar operasyona bağlı ve postoperatif olarak sınıflandırılmıştır.

Bulgular: Operasyona bağlı komplikasyonlar; 1 mesane içine uygulama, 6 erken kaçak, 4 yara enfeksiyonu, 3 kateter çıkış yeri enfeksiyonu, 3 peritonit ve 2 rektus kası hematomudur. En sık postoperatif komplikasyon peritonit idi; 2930 hasta ayında 54 peritonit atağı (her 54.3 ay için 1 atak) gözlendi. Diğer postoperatif komplikasyonlar; 23 hastada 35 kateter çıkış yeri enfeksiyonu (her 83.7 ay için 1 olgu), 4 kateter obstrüksiyonu, 1 inguinal herni, 6 geç kaçak ve 7 umblikal herni idi.

Sonuç: Bu çalışmada, peritonit, majör komplikasyon, diyalizat kaçağı, kateter çıkış yeri enfeksiyonu, insizyonel ve inguinal herni oranları diğer serilerden düşük ya da diğer serilerle benzer bulunmuştur. Kateterin yerleştirilmesindeki titiz cerrahi teknik ve göbek altı paramedian -rektus kası aralanarak- uygulanan yaklaşım düşük komplikasyon oranları sağlamıştır. Sonuç olarak, ortalama kateter ömrü pek çok çalışmadan uzun bulunmuştur (29.3 ay).

Anahtar Kelimeler: Peritoneal diyaliz; komplikasyonlar; cerrahi teknik, böbrek yetmezliği

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Chronic renal failure (CRF) requiring dialysis or transplantation is known as end-stage renal disease (ESRD). The treatment alternatives for ESRD include haemodialysis, peritoneal dialysis (PD), and kidney transplantation.

PD has become a widely used alternative to haemodialysis for selected patients with CRF.[1] PD at home allows patients to be flexible in terms of schedule and travel and in some cases, allow full-time employment. Haemodialysis requires a functioning arterial venous dialysis access and may be accomplished at home or in a medical centre. There are 3 types of peritoneal dialysis, Continuous Ambulatory Peritoneal Dialysis (CAPD), Continuous Cycler-Assisted Peritoneal Dialysis (CCPD) and Nocturnal Intermittent Peritoneal Dialysis (NIPD).

In CAPD, the patient drains a fresh bag of dialysis solution into the abdomen. After 4 to 6 or more hours of dwelling time, the patient drains the solution back into the bag. This cycle is then repeated with a fresh bag of solution. There is no need for a machine for CAPD; all the patient needs is gravity to fill and empty the abdomen. Typically 3 or 4 exchanges during the day and 1 evening exchange with a long overnight dwell time while the patient sleeps are performed.

CCPD uses an automated cycler to perform 3 to 5 exchanges during the night while the patient sleeps. In the morning, the patient starts an exchange with a dwell time that lasts through the entire day.

NIPD is like CCPD, only the number of overnight exchanges is greater (6 or more) and the patient does not perform an exchange during the day. NIPD is usually reserved for patients whose peritoneum is able to transport waste products very rapidly or for patients who still have substantial remaining kidney function.

The most common form of PD, CAPD, does not require a machine. As the word 'ambulatory' suggests, the patients can walk around with the dialysis solution in their abdomen. Other forms of PD require a machine called a cycler to fill and drain the abdomen, usually while the patient sleeps.

PD requires the use of a permanent PD catheter. Soft silicone rubber or porous polyurethane catheters are placed through the abdominal wall into the peritoneal cavity. The most commonly used access device is a catheter described by Tenckhoff and Schechter in 1968.[2] It has Dacron cuffs that merge with the scar tissue to keep it in place (Dacron is a polyester fabric). The end of the tubing that is inside the abdomen has many holes to allow the free flow of solution in and out.

PD for the treatment of renal failure was first reported in 1923, it was initially tested in guinea pigs.[3] Tenckhoff and Schechter reported their modifications in 1968.[2] The use of Tenckhoff catheters are now widespread and may be used as an interim measure in acute renal failure or while vascular access is being obtained. PD may also be the definitive treatment for ESRD in patients who are not candidates for haemodialysis.

No contraindications are absolute, but relative contraindications are cellulitis of the abdominal wall, abnormal thoracoabdominal communication, fresh intra-abdominal vascular prosthesis, fresh abdominal wound, hernias, inflammatory bowel disease, adhesions, and gastrointestinal stomas.

Advantages of CAPD include the reduction of dietary and fluid restrictions and shunt problems, increased mobility and independence and a reduction in dialysis related symptoms. However, the technique of CAPD is not free from complications and not all patients are suitable for this form of therapy.

Such a catheter may be placed successfully by a variety of techniques including open surgical, percutaneous, peritoneoscopic, and laparoscopic placements. Complications of the placement and use of the peritoneal catheter may result in an inadequate and interrupted dialysis, multiple manipulation or insertion of the catheter or is a risk factor to infection. All of these are frustrating for the patient, the nephrologist, and the surgeon. A successful PD program is quite dependent on the proper placement of a permanent PD catheter. The purpose of our current study was to determine the advantages and complications of Tenckhoff catheter insertion via rectus muscle-splitting technique with respect to other placement methods reported before.

Material and Methods

A retrospective study of 106 consecutive Tenckhoff catheter insertions in 100 patients (45 males 55 females) was undertaken over a 6-year period. Mean age was 50.7 and range was 18-73 years. The patients were hospitalized in a university hospital with an active renal medicine and dialysis program. The etiology of renal failure and reasons of catheter placement are presented in Table 1. All catheters were double cuffed and were placed under direct vision in the operating room. Local anaesthesia with or without sedation was used for all catheter insertions. The patients were administered cefazoline sodium 1000 mg via intravenous route before Tenckhoff catheter placement for antimicrobial prophylaxis. The urinary bladder was decompressed by Foley catheter.

Infraumbilical paramedian muscle-splitting incision was preferred for all placements. After an incision of 3 to 4 cm, the dissection was carried to the anterior layer of the rectus sheath, which was opened to expose the rectus muscle. A curved Kelly clamp was used to make an opening on the rectus muscle. The peritoneum was then grasped and a small opening was formed with scissors to allow passage of the catheter. A purse-string suture was then placed around the catheter to obtain a watertight seal around the deep cuff. The deep cuff was attached to the peritoneum above the peritoneum to preclude intra-abdominal adhesions with the same suture. Consequently, the lower cuff was positioned into the rectus muscle. Saline 50 cc was instilled into the catheter after checking for free irrigation and aspiration. Anterior layer of rectus sheath was closed with 00 polypropylene, continuously. Thus, the catheter was positioned at the upper end of the sheath. The catheter was then brought out through a 5-7 cm subcutaneous tunnel 3-4 cm far from the incision. A caudally directed exit site was provided to lower the incidence of exit-site infections. The skin was then closed (Figure 1, 2).

Table 1. Renal failure etiology.

Diagnosis	No of patients
Hypertension	37
Diabetes mellitus	28
Glomerulonephritis	12
Hypertension + Diabetes mellitus	11
Congenital renal disease	3
Other diseases	9
Total	**100**

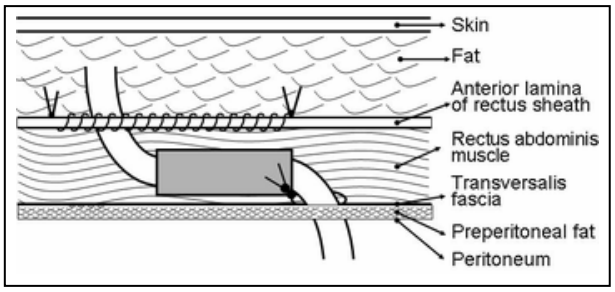

Figure 1. Median section of the abdominal wall. Deep cuff was positioned into the rectus abdominis muscle fibres.

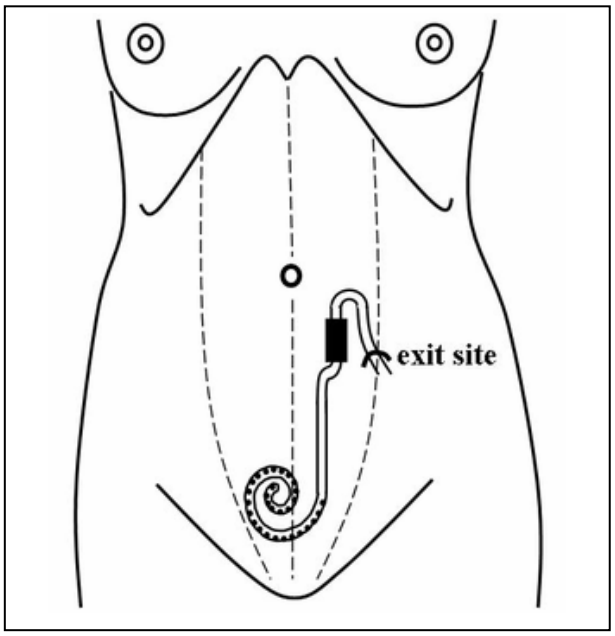

Figure 2. The catheter was brought out through a subcutaneous tunnel 3-4 cm away from the incision. A caudally directed exit site was provided.

Results

Complications of CAPD using the Tenckhoff catheter may be related with the operative procedure itself (placement of the catheter) or the postoperative period.

Table 2. Complications associated with the operation.

Complication	Number of patients
Urinary bladder placement	1
Leakage of dialysate	6
Wound infection	4
Exit site infection	3
Peritonitis	2
Rectus muscle haematoma	2
Total	**18**

Complications of CAPD Related with The Operative Procedure

Nineteen operative complications were encountered (Table 2). Placement of the catheter into the urinary bladder was recognized on the same day. The catheter was removed and a 7-day urethral catheterization was performed without laparotomy.

Early leakage: Leakage of dialysate from the exit site occurred in 6 patients who underwent immediate PD. During the 2 week period after the leakage, haemodialysis was performed and no leakage reoccurred. The catheter was not replaced in any case.

Wound infection: Wound infection occurred in 4 patients, but no catheter removal was required. Open wound dressing without antibiotic therapy was successful for all patients. No causative organism was identified on culture.

Exit site infection: Three exit site infections occurred around the catheter at the early postoperative period and were treated with oral amoxicillin clavulanate and topical antibiotics.

Peritonitis: Peritonitis determined within 72 hours after catheter placement was recognized as surgery related peritonitis, and occurred in 3 patients. All were treated successfully. *Pseudomonas* was identified in one patient and treated with intravenous cefoperazone sulbactam. No organism was identified from the other 2 patients and peritonitis that resolved spontaneously was considered chemical peritonitis.

Haematoma: Five patients suffered rectus sheath haematoma and these haematomas resorbed spontaneously.

Complications of CAPD Throughout The Postoperative Period:

Complications which were not related with the surgical procedure were listed in Table 3.

Peritonitis: Peritonitis occurred in 35% of the total number of patients (n= 35). Thirty-five patients had 54 episodes of peritonitis that required hospitalization. The peritonitis rate for CAPD was one episode for every 54.3 months. Twenty-two patients had 1 episode, 8 patients had 2, 4 patients had 3 and 1 patient had 4. *Staphylococcus aureus* was the organism most often identified on culture of the dialysate (59%) (Table 4).

The treatment of peritonitis included the addition of ceftazidime and cefazolin to dialysate, and usually the administration of systemic antibiotic therapy also. Excluding 7 cases, all peritonitis cases were successfully treated medically. Exit site infection with catheter occlusions was accompanied in 5 cases. As a result, occluded catheters were replaced with new ones after the peritonitis and exit site infections were treated. In 2 patients

Table 3. Non-operative complications.

Complications	Number of patients	Episodes
Peritonitis	35	54
Exit site infection	23	35
Outflow obstruction	4	4
Late leakage	4	6
Inguinal hernia	1	1
Umbilical hernia	7	7
Total	**74**	**107**

Table 4. Causative organism of peritonitis.

Organism responsible	Number of cases
No growth	22
Staphylococcus aureus (methicillin-susceptible)	9
Staphylococcus aureus (methicillin-resistant)	4
Escherichia coli	4
Pseudomonas aeruginosa	4
Group D streptococci	2
Streptococcus viridans	2
Other	7
Total	**54**

Table 5. Causative organism of exit site infection.

Organism	Number of cases
No growth	20
Staphylococcus aureus	6
Coagulase negative staphylococci	7
Acinetobacter	1
Klebsiella pneumonia	1
Total	**35**

peritoneal catheter was removed and haemodialysis was initiated. No patient died from uncontrollable peritonitis and sepsis.

Exit site infection: Twenty-three patients had 35 exit site infections around the catheter on CAPD. Thirteen patients had 1 episode of exit site infection, 8 patients had 2, and 2 patients had 3. The causative organisms were mostly *S. aureus* and coagulase negative staphylococci (Table 5). Five patients required catheter replacement for control of infection.

Late leakage: In our series 6 late leakages (after 2 weeks of catheter insertion) occurred in 4 patients, 1 patient had 3 episodes and 3 additional patients had 1 episode each.

Catheter occlusion and catheter replacement: Fourteen catheter obstructions occurred in 106 Tenckhoff catheter placements. In 6 cases the obstructions resolved with manual flushing. In 2 cases, kinking of the catheter was detected and required surgical revision and reposition of the catheter tip. Exit site infection with peritonitis was accompanied in 5 of the catheter occlusions. In these cases, catheter occlusion did not dissolve. Subsequently, occluded catheters were replaced after peritonitis developed and exit site infections were treated. One other catheter replacement was performed, because of exit site infection resistant to medical therapy.

Hernia: One unilateral inguinal hernia and 7 umbilical hernias occurred in the CAPD patients. All were repaired with tension free technique and catheters were left in place. No incisional hernia was detected in our series.

Catheter outcome: The average catheter life was 29.4 months (range 1 day-84 months). Sixty-three patients (62%) were currently being treated with CAPD. Twenty-four patients (23%) died while on CAPD. Eight patients (8%) had undergone renal transplantation. CAPD therapy was changed with haemodialysis because of catheter related peritonitis in 2 patients (2%) and ultra filtration insufficiency in 5 patients (5%). Refractory peritonitis (n= 5) and poor ultrafiltration (n= 5) accounted for 10 of the 23 technical failures, making peritonitis and poor ultrafiltration the most common reason for stopping CAPD. Other causes of technical failure were; 2 catheter obstructions (kinking), 1 exit site infection resistant to medical therapy, and 8 renal transplantations.

Discussion

Peritonitis was the most common complication in the postoperative period. Peritonitis was defined as return of dialysate fluid with a leukocyte count of greater than 100/mL, with symptoms of peritonitis include abdominal pain, nausea, vomiting, and anorexia and the physical findings including fever, abdominal tenderness, abdominal guarding, and hypoactive bowel sounds. Skin bacteria (mostly *S. aureus*) were the most common organisms causing infection in concordance with other studies.[2,4-8]

The overall peritonitis rate in our study was one episode every 29.3 months. The Renal Association (the national society of renal physicians in the UK) published 'Recommended Standards for the Treatment of Adult Patients with Renal Failure,[4] This document stated that peritonitis rates should be less than one episode per 18 months. The incidence of peritonitis in PD patients in general ranges from 6.7 to 19.2 episodes per patient months (Table 6).[2,4,5,9-12] Our peritonitis rate was lower compared to the Renal Association standard and to the series stated above. Peritonitis is a serious complication that can lead to death.[11,13,14] No patient died as a result of peritonitis or other PD complications in our series.

Table 6. Frequency of peritonitis in general population undergoing PD.

Author & Reference	No. of patients	No. of PD	Frequency of peritonitis (episode/patient months)
Ortiz AM[9] (2004)	120	125	6.7
Kavanagh D[4] (2004)	1205	1205	19.2
Başaran Ö[5] (2002)	269	338	15.4
Balaskas EV[10] (1999)	207	225	15
Sanderson MC[2] (1990)	260	311	8.97
Bullmaster JR[11] (1985)	115	145	8.9
Robinson RJ[12] (1984)	140	173	10.5
Our Study	**100**	**106**	**29.3**

Table 7. Catheter Survival Rates.

Author (Publication year)	No. of patient	No. of PD	Cath surv* 1 year (%)	Cath surv 2 years (%)	Cathe surv 3 years (%)	Cath surv 4 years (%)	Cath surv 5 years (%)
Rinaldi S [20] (2004) (PediatricPatients)	363	503	78.1	58.5	43.8	34.6	-
Ortiz AM [9] (2004)	120	125	97	-	-	-	92.2
Balaskas EV [10] (1999)	207	225	97	92	87	-	-
Apostolidis NS [17] (1998)	203	222	75	37	-	-	-
Eklund BH [19] (1995)	103	110	92.4	82.4	-	-	-
Sanderson MC [2] (1990)	80	60	53	-	-	-	-
Francis DMA [14] (1984)	122	173	88	64	-	-	-
Our Study	**100**	**106**	**89**	**85**	-	-	-

* Catheter Survival.

Inadvertent placement of a catheter into a distended bladder was the only major operative complication. Placement of a urinary catheter before the procedure will prevent this complication. No gastrointestinal tract complication was encountered related to the operative procedure. The risk of bowel perforation was avoided by the opening of the peritoneum and allowing the air inflow to the abdominal cavity. Therefore, the major complications in our study (0.9%) were lower than those in other series.[2,5,11,14,15] Several major and frustrating complications were reported in the literature such as refractory peritonitis with death, small and large bowel perforation that needs laparotomy, evisceration, and pelvic hematoma.[2,5,11,13-17] Catheter related peritonitis and exit site infection together was the major cause of catheter replacement. The rate of exit site infection in both peroperative and postoperative period together was 1 case per 78.8 months. The main cause of CAPD failure was ultra filtration insufficiency (5 patients) and the second cause was severe peritonitis in 2 patients. However, in most studies, refractory or recurrent peritonitis is the most common reason for stopping PD.[2,4,10-14,16,18,19] Other causes of technique failure were exit site (tunnel) infection, poor ultrafiltration, catheter obstruction, peritoneal dialysate leakage and cuff extrusion.[2,4,10,14,16,18-22]

In our study with the Tenckhoff catheter insertion via rectus muscle-splitting technique, the rate of catheter obstruction that required catheter removal was low. Only in 2 cases, kinking of the catheter was detected and required surgical revision. The remaining 5 catheter obstructions accompanied exit site infection with peritonitis. Reports suggest that operative technique, not the catheter design, is a major determinant of successful catheter function.[12]

Catheter survival rates in our study in the 1st and 2nd years were 89% and 85%, respectively. These results were also comparable with other studies (Table 7).[2,9,10,14,17,19,20]

Leakage of dialysate from the peritoneal cavity occurred in 6 emergent peritoneal dialysis patients, late leakage developed in 4 patients. Early leakage rate was low.[11,14] We prefer waiting for 2 weeks to start CAPD after placement of the catheter to guarantee peritoneal and wound healing, as recommended.[23] Additionally, the deep cuff was positioned into the rectus abdominis muscle fibres. These measures were taken to prevent late leakage. The prevalence of peritoneal leak varies from 1% to 27%.[24] The most important factor associated with exit site (pericatheter) leaks is the misplacement of the deep cuff in the rectus muscle.[25]

The reported prevalence of hernia in PD patients ranges from 9% to 25% in most series.[24] The infraumbilical paramedian muscle-splitting incision minimized the incisional hernia incidence to nil. Reports suggest that paramedian incision is associated with significantly fewer incisional hernias than the midline incision.[26,27]

In conclusion, the low incidence of peritonitis, exit site infection, leakage, catheter obstruction and hernia in our study is probably related to fine installation technique that is rectus muscle-splitting. Consequently, we observed a good catheter survival.

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