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One-year outcomes of percutaneous continuous ambulatory peritoneal dialysis catheter insertion by nephrologists: First experience from Sri Lanka

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Abstract

Introduction: Continuous ambulatory peritoneal dialysis (CAPD) via a catheter placed in the peritoneum is an established mode of renal replacement therapy. CAPD catheters are placed using either percutaneous or surgical techniques. Percutaneous method is less invasive and avoids the need for general anaesthesia, surgical space, and expertise. This study was conducted to measure one-year outcomes of percutaneous CAPD catheter insertions performed by a nephrology team; the first experience from Sri Lanka.

Methods: We retrospectively studied 96 patients in two centers, who underwent percutaneous CAPD catheter insertion over two years with a follow-up period of minimum one year. The catheter was placed using modified Seldinger technique under local anesthesia with ultrasound guidance.

Results: Majority were males (78.1%) with a median age of 56 years. Most were on haemodialysis (HD) (85.4%) prior to CAPD catheter insertion. The commonest reason for opting for CAPD was to avoid hospital visits for HD (54.2%). During the follow-up of one year, 85.4% were free of complications. Frequent non-infectious complications were catheter removal (12.5%), visceral injury (4.2%), primary insertion failure (4.2%), and catheter dysfunction (2.1%). Pre-training peritonitis was found in 2.1% with an overall peritonitis rate of 0.4 episodes per patient a year. There was no significant association between catheter-related complications and gender ($p=0.68$), previous abdominal surgery ($p=0.54$), diabetes mellitus ($p=0.84$), and hypertension ($p=0.46$). One-year catheter survival was 92%.

Discussion: One-year outcomes of percutaneous CAPD catheter insertion by nephrologists were efficacious and safe with low complication rates. Hence, CAPD catheter insertion by well-trained nephrologists should be encouraged. Further studies comparing percutaneous versus surgical catheter placement are warranted.

Key words: continuous ambulatory peritoneal dialysis catheter, percutaneous catheter insertion technique, nephrology team

Introduction

The growing incidence of end-stage kidney disease (ESKD) has increased the demand for renal replacement therapy (RRT). Continuous ambulatory peritoneal dialysis (CAPD) is advantageous because it is home-based, requires fewer hospital visits, and enhances the quality of life of patients and families.[1,2] The success of CAPD is determined by various factors including the quality of catheter placement.[3] Since CAPD is a lifeline for the patient, the successful placement of a CAPD catheter is of paramount importance.

CAPD catheters are implanted utilizing a variety of techniques, including percutaneous and surgical approaches. PD catheters were traditionally implanted by surgeons either by open or laparoscopic surgery.

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However, catheter placement can be performed percutaneously at the bedside, which eliminates the need for a surgical environment.[4,5] Furthermore, it is a less invasive technique conducted under local anesthesia with minimum transcutaneous access.[6] Hence, it enables rapid initiation of CAPD.[4] Percutaneous procedure based on Seldinger technique was performed initially which was later modified by combining a fluoroscope or peritoneoscopy assistance.[3] This procedure is currently performed by surgeons, interventional radiologists as well as nephrologists.

Several comparative studies have detailed the outcomes of surgically and percutaneously implanted catheters, with percutaneous catheter placement by competent nephrologists outperforming surgical installation.[3,4,9,10] This procedure of installing CAPD catheters by nephrologists was recently established in Sri Lanka. Therefore, we conducted this study to investigate the complications of CAPD catheters inserted by the nephrology team, describing the first Sri Lankan experience.

Methods

This retrospective study was conducted at two selected tertiary care centres in Sri Lanka: Provincial General Hospital (PGH), Badulla, and National Hospital of Sri Lanka (NHSL), Colombo. Data on patients who underwent CAPD catheter insertion from January 2020 to March 2022 were extracted from nephrology unit database maintained by data collection from patients pre and post procedure and during follow up clinic visits. Data on demographics, comorbidities, details on previous modes of kidney replacement therapy, and complications of CAPD catheter insertions were extracted from the above database. During the period, 96 patients with ESKD underwent CAPD catheter insertion by the nephrology teams. These patients were followed up for a period of at least one-year to assess the outcomes. Ethical clearance was obtained from the Ethical Review Committee at the National Hospital of Sri Lanka, Colombo.

The procedure of catheter placement

The indexed patient was kept fasted for 8 hours and bowels were prepared with single enema (sodium phosphate). Prophylactic antibiotic (intravenous ceftazidime 1g) was given one hour prior to procedure. Then CAPD catheter was placed using a modified Seldinger technique under strict aseptic conditions. After cleaning, the deep cuff position was landmarked considering the belt line and the contour of the abdomen. Under local anaesthesia, a paramedian incision was made and an introducer needle was placed into the peritoneum with ultrasound guidance. Free flow of dialysate into the peritoneum was used to confirm the correct position followed by instillation of dialysate. Through a guide wire inserted into the cavity, a peel of sheath and a dilator were placed. Subsequently, the CAPD catheter was advanced through the peel of the sheath. Later, the sheath was torn apart and the catheter was placed within the peritoneum cavity. The deep cuff was anchored above the fascia of the rectus sheath using a purse-string suture. This was followed by landmarking the exit site and making a subcutaneous tunnel with a superficial cuff sitting within it. The placement was confirmed with an x-ray abdomen. Patients underwent flushing of the catheter with 1 litre of 1.5% CAPD solution, on day 5 and day 10 respectively. CAPD exchanges were started after a break-through period of 14 days.[11]

Definition of outcomes

The complications of PD catheter can be either infectious or non-infectious and can be further classified as early ($\leq$1 week) or late (>1 week). Infectious complications included peritonitis, exit-site infection and tunnel infection.[12] Oedema at the exit site, erythema, and a purulent discharge was used to define an exit-site infection while oedema, erythema, and, tenderness over the catheter pathway were used to define a tunnel infection.[9,13] Further, we used clinical presentation, turbid dialysate (white blood cells (WBC) >100/mm^3 with at least 50% of WBCs being polymorphonuclear leukocytes), or a positive culture to diagnose peritonitis.[6,13] Pre-training peritonitis was defined as peritonitis occurring from CAPD catheter insertion to initiation of CAPD.[14]

Non-infectious complications of CAPD catheter insertion include mechanical catheter dysfunction, dialysate leakage, hernia, bleeding, visceral injury, and insertion failure.[12] Catheter dysfunction was described as a mechanical failure in the inflow or outflow of dialysate.[15] Catheter obstruction or catheter migration can result in catheter dysfunction.[10] Furthermore, if dialysate leaks from either the exit site or incision, it was described as a catheter leakage.[13,15] Catheter survival was defined as the ability to continue CAPD without encountering any catheter-related interventions such as removal, replacement, or any surgical or radiological interventions.[16,17] Primary insertion failures or catheters removed following transplantation was not included in the analysis for catheter survival.

Statistical analysis

Statistical analysis was performed with SPSS version 25. Categorical variables were described with numbers and percentages while median and range

were used to present the continuous variables. A p-value <0.05 was considered significant during statistical analysis.

Results

During the study period, 96 patients underwent CAPD catheter insertion at the two centres. The baseline characteristics of the study population are shown in Table 1.

Table 1. Demographic characteristics of patients

Characteristics	*Patients (n,%)*
Number of patients	
PGH – Badulla	82 (85.4%)
NHSL – Colombo	14 (14.6%)
Gender	
Male	75 (78.1%)
Female	21 (21.9%)
Previous abdominal surgery	9 (9.3%)
Comorbidities	
Hypertension	84 (87.5%)
Diabetes mellitus	51 (53.1%)
Dyslipidaemia	39 (40.6%)
Heart disease	29 (30.2%)
Other	23 (23.9%)

The majority were males (75, 78.1%) with the median age of CAPD catheter insertion of 56 years (Inter-quartile range -IQR 48-62). Median BMI was 24.6 kg/m^2. Hypertension (n=84, 87.5%) was the commonest comorbidity in the studied population.

Majority of the patients were on haemodialysis (HD) (n=82, 85.4%) prior to CAPD initiation. The most common reason for opting for CAPD was to avoid repeated hospital visits for HD (54.2%) followed by insufficient cardiovascular fitness for HD (26%).

During the follow up of one-year, 85.4% were free of complications (Table 3). Non-infectious complications were more frequent. Catheter removal was the most common non-infectious complications followed by visceral injury (4.2%) and insertion failure (4.2%), catheter dysfunction (2.1%), immediate haemorrhagic drain (2.1%), and catheter leakage (1.0%). In 2.1% of our population, pre-training peritonitis was present. The overall peritonitis rate was 0.4 episodes per patient a year. Out of other catheter-related infections, we encountered 2.1% of exit-site infections, but not a single tunnel infection. There was no significant association between catheter-related complications and gender (p=0.68), previous abdominal surgery (p=0.54), diabetes mellitus (p=0.84), and hypertension (p=0.46). One year catheter survival rate of the patient cohort was 92%.

Table 2. Details on CAPD catheter initiation

	Patients (n,%)
Initial Mode of RRT	
HD	82 (85.4%)
RRT – Initiated with CAPD	14 (14.6%)
Reason for opting for CAPD	
Avoid repeated hospital visits for HD	52 (54.2%)
Insufficient cardiovascular fitness for HD	25 (26%)
Non-affordability for private HD	9 (9.4%)
Exhausted HD vascular access	8 (8.4%)
Recurrent HD CRBI*	2 (2.1%)

*CRBI – Catheter-related bloodstream infections

Table 3. Complications of PD catheter insertion

	Patients (n,%)
Complications - free	82 (85.4%)
Mechanical Complications	
Removal	12 (12.5%)
Drainage failure resulting in fluid overload	4 (33.3%)
Recurrent peritonitis	3 (25.0%)
Removal for transplant	3 (25.0%)
Fungal infection	2 (16.7%)
Visceral injury (Bowel perforation and bowel puncture)	4 (4.2%)
Primary insertion failure	4 (4.2%)
Catheter dysfunction	2 (2.1%)
Immediate haemorrhagic drain	2 (2.1%)
Leakage	1 (1.0%)
Infectious complications	
Pre-training peritonitis	2 (2.1%)
Exit-site infections	2 (2.1%)
Tunnel infection	0
Peritonitis/year	0.4

Discussion

Percutaneous CAPD catheter insertion by nephrologists was recently implemented in Sri Lanka. Therefore, this study was carried out to establish the efficacy of the method in a resource-limited setting like Sri Lanka. We studied 96 patients who underwent PD catheter insertion at two selected tertiary care centers. CKD was highly prevalent among males,[18] probably giving rise to high incidence of CAPD catheter insertion in male patients. The patients' reluctance to undergo this novel procedure, lack of trained personals, and resource limitations were postulated to be the reasons for majority to have haemodialysis as initial RRT. Catheters were introduced using a less invasive modified seldinger technique, which nephrologists prefer due to the established benefits stated earlier. Towards the latter one-year, the technique was modified by incorporating USS guidance. The nephrology team has maintained a median break-in period of 15 days, which is approximately in accordance with the International Society for Peritoneal Dialysis (ISPD) standards.[10] The percutaneous catheter implantation approach yielded a significant complication-free rate of 85.4%.

The most frequent non-infectious complication was catheter removal where the commonest indication being drainage failure resulting in fluid overload. However, common reasons identified in literature for catheter removal are catheter dysfunction and refractory peritonitis while others are patient death, transfer to HD, renal transplantation, transfer to another PD centre, catheter removal by abdominal surgery, and partial recovery of renal function.[19]

The other frequent non-infectious complications were insertion failure (n=4, 4.1%) and visceral injury (n=4, 4.1%). In comparison to the literature, the current study revealed a higher rate of insertion failure.[12] Non penetration of rectus muscle and mal positioning of catheter within rectus sheath were identified as the causes for insertion failure. Additionally, since this is Sri Lanka's first experience with this procedure, the significant insertion failure rate could be attributable to a lack of experienced operators and resources. Furthermore, the failure to incorporate ultrasonography guidance at the outset may have led to the above-mentioned high rate. During the one-year period in which we used ultrasound guidance, there were no insertion failures among 55 catheter insertions.

ISPD recommends <1% instances of visceral injury.[17] In our study visceral injury, (bowel puncture and bowel perforation) was reported in 4.2% (n=4) of patients. Bowel puncture was diagnosed by the drainage of feculent dialysate effluent, and it was managed conservatively with supportive care. In the single event of bowel perforation, exploratory laparotomy, and repair were performed. Conversely, in a comparative study done by Sampathkumar et al.,[10] among 46 patients only one patient encountered bowel injury with the percutaneous technique. Furthermore, in a similar study, there was no reported visceral damage, which the authors attributed to the avoidance of utilizing a stylet in the percutaneous approach.[9]

Seventy five percent of the visceral injuries were observed in the CAPD catheter insertions performed in first three months of our study. Later, we incorporated instilling approximately 500ml of dialysate into the peritoneal cavity prior to introducing the guide wire. Further, we modified the technique by incorporating ultrasound scan-guided needle puncture. This might have led to a minimization of bowel injury rates towards the latter part of the catheter insertions. Installing dialysis solution prior to insertion of the needle and refraining from forceful insertion has been identified to reduce the risk of visceral injury and incorrect placement of the catheters.[9]

Catheter dysfunction following obstruction or migration of the catheter tip may cause drainage failure.[10] Only two (2.1%) of our patients had catheter dysfunction; comparatively lower than previous studies where rates range from 9.64% to 14.1%.[6,9,12,18]

One patient (1.0%) experienced early catheter leakage, which is lower than in prior studies.[9,10,18] Sampathkumar et al., discovered early leakage in three out of 25 instances in their comparative analysis of percutaneous and open surgical approaches (12%) and the lower rate was attributed to the positioning of the inner cuff laterally and proper fixation in the rectus muscle via a paramedian incision.[10] In a similar study in Turkey, delaying catheter use after placement, low volume initial exchanges, refraining from a frequent dressing of the incision and exit site, avoiding forceful insertion, lateral placement of inner cuff via a paramedian incision, and well fixing the catheter in rectus muscle were identified as contributing factors for a lower rate (0.7%) of early catheter leakages.[9]

Even though there were two patients with haemorrhagic drain, none of our patients had severe haemorrhage necessitating blood transfusion, which is consistent with data from a United Kingdom study.[6] None of our patients developed hernia during the follow-up period. The overall non-infectious complication rate was 13.5%.

The major infectious complication identified in our sample was also peritonitis. We encountered 2 (2.1%)

instances of pre-training peritonitis. The overall peritonitis rate in our population was 0.4 episodes per patient year which is consistent with ISPD recommendations.[14] In our study, 2 (2.1%) of the patients had an exit-site infection while none had a tunnel infection. It is consistent with recommended <5% rate of exit site or tunnel infection rate of catheter placement within 30 days.[17] The low rate of exit site and absence of tunnel infections can be explained by maintaining a standard break-in period in delaying catheter use, starting with low exchanges at first and cautious handling of the exit site and incision.

Mode of insertion, design of the catheter, and exit site location determine the CAPD catheter survival.[9] According to ISPD recommendations, a one-year survival rate of >80% is accepted.[17] Our study reported a 92% of 1-year catheter survival rate in accordance with the higher catheter survival rate reported in the literature.[9,12,19,20] We did not experience any procedure-related deaths.

Limitations

We acknowledge several limitations to our study. Our sample size was limited as the procedure was recently implemented in Sri Lanka. This might affect the generalizability of the findings. Furthermore, due to the small sample size, we did not compare the two centers. Moreover, a multicenter study would provide more generalizable results. Further, a comparative study with the surgical technique was not performed due to the non-availability of surgical insertions carried out in these centers.

Conclusion

In conclusion, our study indicates acceptable catheter outcomes with percutaneous CAPD catheters inserted by nephrologists, describing it as efficacious and safe with lower complication rates. Hence, CAPD catheter insertion by well-trained nephrologists should be encouraged. We recommend further studies comparing percutaneous versus surgical placement.

Author declaration

Conflict of interest

There are no conflicts of interest.

Author contribution

UR and CS researched literature and conceived the study. UR, CS and HW were involved in protocol development, gaining ethical approval, patient recruitment and data analysis. UR and HW wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

Ethical approval

Ethical approval for this study was obtained from the Ethics Review Committee - National Hospital of Sri Lanka, Colombo (AAJ/ETH/COM/2022/JUNE)

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