Straight versus Coiled Peritoneal Dialysis Catheter: Conclusion is Not Straightforward

The innovative technology gradually evolved with uncovering a novel peritoneal dialysis (PD) catheter in the evolution of PD as the modality of renal replacement therapy. In the early years before the discovery of the PD catheter, also known as the "Tenckhoff catheter," in 1968 by Henry Tenckhoff, there was no specific device for PD.[1,2] Instead, the instruments used in general surgery and urology were used as peritoneal access. Foley catheters, mushroom-tip catheters, whistle-tip catheters, polyethylene tubes, simple soft rubber tubes with or without side holes, stainless steel sump drains, and even glass drains were tried as peritoneal access, without satisfactory long-term outcomes. The PD process was also associated with multiple complications, such as pressure on intestines of rigid tubes, suction of unsterile air into the peritoneal cavity, plugging of holes, leakage of fluid, and difficulties in fixation of the tube onto the abdominal wall.

The design of the silicone rubber catheter with polyester/Dacron cuffs was a breakthrough for PD. The Tenckhoff catheter could be kept permanently in the abdomen. It became the gold standard for PD access and remained the most widely used catheter worldwide to date. Unfortunately, increased catheter-related complications due to numerous daily manipulations and higher intra-abdominal pressure in PD remained challenging. Despite contemporary improvements in catheter design, none of the currently used catheters is scuffle-free. Poor dialysate flow, tissue suction into the catheter openings, pericatheter leaks, exit-site infections, tunnel infections, and recurrent peritonitis episodes are still frequently encountered. The catheter-related complications with a malfunction in approximately 13% and infections in 48% of patients continue to cause significant morbidity leading to transfers of patients to hemodialysis.[3] To limit these complications and a constant search for new technology, a modification in the intraperitoneal segment was designed. The two most used modifications in the intra-abdominal part of the Tenckhoff catheter were straight and coiled tips of intra-abdominal portions of the catheter. It was assumed that the design of the coiled catheter would allow better separation of the parietal and visceral layers of the peritoneum. It will provide better flow in and out of the catheter, lesser inflow pain, catheter migration, omental wrapping, and trauma to the viscera than the straight catheter. However, to date, eight small, controlled trials comparing straight and coiled catheters yielded inconsistent results. One small trial involving 40 incident PD patients, 20 patients in each group, found no difference in catheter survival or mechanical complications between the straight and coiled catheters. There was a greater rate of exit-site infections in the straight catheter group (0.60 vs. 0.29 episodes/year) compared with the coiled one.[4] Other way around, Nielsen *et al.*[5] reported a marked decrease in catheter migrations and better 1-year catheter survival with the coiled-tip in 77% than straight-tip catheter in 36% of patients. Moreover, seven controlled trials found no significant differences between the two catheter types.[4,6-11] Johnson *et al.*[12] have shown that coiled catheters do not influence the risk for drainage failure caused by catheter malposition compared with straight catheters. They found that there was a significantly increased risk for PD technique failure, primarily because of inadequate dialytic clearance. Stegmayr *et al.*,[13] in their study, also found that coiled catheters had a significantly greater rate of drainage dysfunction caused by malposition (47%) than none with straight-tip catheters. The catheter replacement was required in 41% in the coiled catheter group compared with 7% in the straight catheter group.

A systematic review and meta-analysis on comparing the straight versus coiled-tip catheters found that catheter removal rate and survival at 1 year after insertion were significantly in favor of straight catheters. There was no difference between straight versus swan-neck and single versus double-cuffed catheters, on pooling the data.[14] Xie *et al.*[15] showed that the rates of catheter tip migration were similar between the straight and coiled groups before 8 weeks; however, after 8 weeks, catheter tip migration was 6.4 times higher in the coiled catheter group. The meta-analysis part of the study revealed that coiled catheters were significantly associated with increased risk of catheter tip migration.[15] However, there are several concerns that remain related to these studies with trial heterogeneity, poor overall study quality, and inability to show an intervention-related mechanism for the decrease in mortality, particularly in view of similar rates of peritonitis, exit-site/tunnel infections, and catheter removal/replacement observed with the two catheter types.

After the publication of the two meta-analyses, to resolve the issue, a well-planned randomized study was conducted with 151 straight and 155 coiled catheter groups in 2018, which again showed a 0.7% catheter dysfunction with straight and 5.8% with the coiled catheter groups during a mean follow-up of 21 months. Straight catheters had a 5.1% lower risk for catheter dysfunction than coiled catheters. This study also reiterated the findings in favor of the straight catheters.[16] The present Malaysian study,[17] in this issue of the *Indian Journal of Nephrology*, with 126 patients (75 patients with the coiled PD catheter and 51 patients with the straight PD catheter) emphasized

primarily about the exit-site infection, tunnel infection, and peritonitis rates between the two groups. They observed similar peritonitis rate, exit-site infection rate, and tunnel tract infection rate in the coiled and straight PD catheter groups. A critical appraisal of the study was infection episodes in both groups were mainly caused by gram-negative organisms, particularly *Escherichia coli* and *Klebsiella pneumoniae*. The causative organisms were also similar in both straight and coiled catheter groups. The findings of increasing episodes of gram-negative infection in PD program is in contrast to most of the findings from the developed world showing gram-positive infection resulting from touch contamination as major causes of infection. Moreover, we have also published as early in 2003, that gram-negative peritonitis is predominating over gram-positive peritonitis episodes in the region.[18] One of the primary reasons for lower gram-positive episodes could be improving connectology in PD over the years with less spiking with double-bag drainage system and flush before fill techniques, which resulted in relatively reduced touch contaminations and relatively higher peritonitis with organisms of bowel origin. It is also possible that people's bowel clearance and defecation habits, in general, maybe posing them with a high gram-negative infection of bowel origin.

The Malaysian study[17] again reiterates that the catheter design in terms of coiled versus straight catheter does not impact PD catheter-related complications, including infections. Woefully, studies conducted in the area had multiple limitations with small sample size and poor allocation and randomization. The lack of stratification by the surgeon puts forth the dubious generalizability with excess catheter failure rates than expected in many studies. The impact of other changes in catheter design such as single- versus double-cuffed catheters and swan-neck versus straight may be different. The insertion techniques such as laparoscopic, open surgical, trocar, and percutaneous methods had not been properly adjusted in all studies. The varying site of exit of catheter, median versus lateral insertion sites, may also impact the complications.

Many clinical practice guidelines of the International Society of Peritoneal Dialysis, the British Renal Association, and the European Dialysis and Transplant Association do not advocate the superiority of any specific catheter.[19-21] The double-cuffed catheter, either straight or curled, remains the standard of care, as per convenience and choice of the center. Still, there remains a need for well-designed, randomized controlled studies in the field, involving experts in trial methodology and appropriate outcome measures to find out the superiority of one design of the catheter over the other.

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