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FLUOROSCOPIC PLACEMENT OF PERITONEAL DIALYSIS CATHETERS: A HARVEST OF THE LOW-HANGING FRUITS

Progress in interventional methodology should aim to minimize the invasiveness of a procedure, and at the same time improve outcome quality, assure patient safety, and demonstrate cost-effective resource utilization. Often, the technological innovations in one medical application cannot be effectively transferred to another without a transition period wherein the borrowed technology first undergoes procedure-specific adaptation. Such has been the case in the use of fluoroscopy and laparoscopy for the creation of peritoneal dialysis (PD) access. Impediments to assessing the true value of these technologies in catheter placement include variations in operator performance, departures from basic procedural methodology that are recognized as best demonstrated practices, and incomparability of study populations. Until these confounding factors are taken into account, the debate of which is the best method to perform PD catheter implantation will likely continue.

In this issue of *Peritoneal Dialysis International*, Moon *et al.* (1) present a retrospective analysis of the largest case series to date of fluoroscopically guided placement of PD catheters. The purported benefits of the fluoroscopic approach are a shorter line to the radiology suite than to the operating room, use of local anesthesia instead of general, smaller cuts with less pain and quicker return to full recovery, and lower cost. Their clinical outcomes were characterized as comparable to more invasive techniques and justified the recommendation that the fluoroscopically guided approach might be the preferred method to establish initial peritoneal access. These alluring attributes of the fluoroscopically guided procedure and the prospect of not having to deal with surgeons or their long backlogs is enough to excite the interest of any beleaguered nephrologist struggling to grow their PD program. A closer look at a procedure that produced a 1-year catheter survival of only 80.0% is warranted, however.

Like all studies employing the modified Seldinger technique for catheter insertion, with or without fluoroscopic guidance, the Moon *et al.* study suffers from considerable patient selection bias that muddles any comparative analysis to other catheter placement approaches. The study subjects had had no previous major abdominal surgery and were non obese (body mass index = 23.3 ± 3.3 kg/m^2); therefore, they were the most ideal candidates for catheter placement. It should come as no surprise that there was a zero incidence of placement failure. In studies that experienced placement failure and/or bowel perforation with the Seldinger needle–guidewire approach, those failures occurred primarily in patients with previous abdominal surgery, obesity, or prior peritonitis (1–8). As a result, the general recommendation is to refer patients to a surgeon if there is any previous history of major abdominal surgery (2,5,6,8–16), gross obesity (3,10,12–14), or prior dialysis-related peritonitis (3,5).

In the Moon *et al.* study, end-stage renal disease patients that were not candidates for the fluoroscopically guided percutaneous approach were excluded from consideration for PD treatment. Although not directly stated in their report, this sole reliance upon one method of catheter placement seemed to be related to the quality and accessibility of their surgical support. Unfortunately, the lack of interested and competent surgical help is a common problem and leaves few options for the nephrologist except to provide what service they can. The downside of the exclusion criteria imposed by the fluoroscopic percutaneous approach is that many patients that might otherwise be considered as candidates for PD are denied the opportunity. The prevalence rate of previous abdominal surgery in unrestricted surgical and laparoscopic populations that include all comers for catheter placement is 45% – 53% (17–20). This means that in a medical community similar to that of Moon *et al.*, the potential candidate pool for PD may have been cut by as much as half.

The modified Seldinger technique utilized by Moon *et al.*, and most other percutaneous approaches with (4,6,21) and without (2,3,7,9,11–14,22) fluoroscopic assistance, is inherently flawed by positioning the peritoneal catheter's deep cuff in the subcutaneous space external to the muscle fascia. Moreover, a number of studies used a midline point of insertion through the linea alba (2–5,9,13,14,22). The subcutaneous and midline tissues do not provide adequate tissue attachment to the deep cuff or sufficient immobilization of the transmural catheter segment, thereby leaving the patient predisposed to pericannular leaks and hernias, catheter tip

migration, and superficial cuff extrusion. For this reason, published guidelines of the International Society for Peritoneal Dialysis have identified as best demonstrated practices to insert the catheter through a paramedian location and to position the deep cuff within the musculature of the abdominal wall (10). Three recent reports of percutaneous catheter placement with (8,16) and without (15) fluoroscopic guidance described lower leak and catheter migration rates by modifying their technique to take the extra step of advancing the deep cuff into the rectus sheath musculature. It should be noted, however, that the observation period in these latter studies was short or not stated and, in the report by Jo *et al.* (15), even though only 2% of patients experienced diminished flow function by the end of the study, the incidence of catheter tip migration was 15.7%. Therefore, the concern remains whether the rather direct passage taken through the abdominal wall by percutaneous approaches is sufficient to immobilize the transmural segment of implanted catheters.

The two major mechanical complications that may lead to catheter failure are leakage of peritoneal fluid and flow dysfunction. In the paper by Moon *et al.*, catheter-related mechanical problems, including leak (12.7%) and flow dysfunction (11.2%), led to removal of 11.2% of their catheters. They concluded that these results were comparable to other percutaneous approaches and better than more invasive techniques of catheter placement. Table 1 summarizes a literature survey of the major catheter implantation approaches and incidences of their associated mechanical catheter complications. To assure a reasonable expectation that the current level of technology was employed and that operator experience with the methodology was optimal, Table 1 includes only reports published since 2000 that described at least 50 catheters with a follow-up of 3 months or longer and provided complete data for mechanical catheter complications (1,11,12,14,15,20,23–28). In light of this literature review, Moon *et al.*'s results may be comparable to other percutaneous approaches and arguably better than conventional surgical placement of catheters, but it clearly falls short of laparoscopically implanted catheters. The significance of this difference between fluoroscopic and laparoscopic results is further amplified by the fact that the laparoscopic study populations included a sizable percentage of patients with prior abdominal surgery. It is well recognized that patients with previous abdominal surgery have a significantly longer procedure time for catheter placement and increased risk of perioperative complications, due mostly to adhesions; (24,25,29); therefore, the lower incidence of catheter complications observed for laparoscopy is noteworthy.

Lower procedure cost is a touted benefit of percutaneous techniques compared to conventional surgical and laparoscopic approaches despite the fact that none of these studies actually present cost data. Any cost–benefit analysis must also consider the expense of rework caused by complications that necessitate catheter revision or replacement (30). Interventional treatment for catheter tip migration includes fluoroscopic manipulation (often requiring repeat sessions), open surgical or laparoscopic salvage, and catheter replacement, the latter as a result of failed fluoroscopic and surgical revision or as the initial management approach. Pericatheter leaks predispose to catheter infection-related peritonitis and persistent leaks call for catheter removal. The necessity for further unexpected interventions may discourage patients from continuing PD and result in early switch to hemodialysis. The incidences of catheter salvage procedures, removal and replacement of catheters, and abandonment of PD with a switch to hemodialysis all figure into the cost-effectiveness of a catheter implantation approach. Although a procedure may have a lower cost, it might not be as cost-effective as a higher priced procedure if the expense of rework and/or modality switch erodes the cost differential.

The huge cost savings that accrue to government-funded healthcare systems when patients are successfully managed long-term with PD compared to hemodialysis essentially trivialize the concerns about differences in costs of various implantation methods (31,32). The savings achieved by PD technique survival beyond even the first year more than wipe out the costs of higher resource-using catheter placement procedures (30,31). It seems, therefore, that the primary effort should be directed toward developing and using implantation techniques that assure the best prospect for long-standing success. This is not to suggest that procedure costs should be ignored; instead, it represents an admonition against being penny-wise and dollar-foolish.

Moon *et al.* and other proponents of catheter placement by the Seldinger approach cite the avoidance of general anesthesia as one of the advantages. Laparoscopic catheter placement under local anesthesia is possible provided that inert insufflation gases (*e.g.*, nitrous oxide and helium) are used instead of CO_2 gas to create the pneumoperitoneum (28,33,34). However, modern anesthetic agents, equipment, techniques, and monitoring systems have improved patient safety under general anesthesia to the point that there is currently no market demand for alternative gas insufflators that enable laparoscopy under local anesthesia. In the large laparoscopic series cited in Table 1, there were no

TABLE 1
Literature Survey of Methods of Peritoneal Dialysis Catheter Implantation and Associated Mechanical Catheter Complications[a]

Implantation method Author (Year)	Catheters (*n*)	Previous abdominal surgery (%)	Mechanical catheter complications Leak (%)	 Flow dysfunction (%)
Fluoroscopically guided				
Moon *et al.* (2008)	134	0[b]	12.7	11.2
Blind percutaneous				
Ozener *et al.* (2001)	133	0	8.3	10.5
Roueff *et al.* (2002)	57	0	17.5	3.5
Dequidt *et al.* (2003)	60	0[b]	18.3	13.3
Jo *et al.* (2007)	51	0[b]	2.0	2.0
Open surgery				
Ozener *et al.* (2001)	82	0	6.1	17.1
Dequidt *et al.* (2003)	78	Not stated	3.9	14.1
Crabtree *et al.* (2005)	63	30.2	1.6	17.5
Soontrapornchai *et al.* (2005)	52	0	1.9	15.4
Tiong *et al.* (2006)	164	26.2	3.7	10.4
Chen *et al.* (2007)	122	14.8	0[c]	13.1[c]
Surgical laparoscopy				
Cala *et al.* (2000)	84	13.1[c]	0	2.4
Crabtree *et al.* (2005)	200	53.0	2.0	0.5
Soontrapornchai *et al.* (2005)	50	0	2.0	6.0
Maio *et al.* (2008)	100	9.0	5.0	6.0
Keshvari *et al.* (2008)	175	47.5[c]	7.4	6.9

[a] Published reports since 2000 that describe at least 50 catheters with ≥3 months of follow-up, and provide complete data for mechanical catheter complications.
[b] Stated policy of excluding patients with previous major abdominal surgery, gross obesity, and/or prior dialysis-related peritonitis.
[c] Data courtesy of personal communications from Chien-Hua Lin (for Chen *et al.*), Zoran Cala, and Amir Keshvari.

perioperative mortalities associated with catheter implantation under general anesthesia (20,23,26,27). Except for what equates to a small fraction of patients with cardiopulmonary instability, the need for general anesthesia should not be viewed as an impediment to performing the most optimal catheter placement procedure. Perhaps the best application for percutaneous Seldinger catheter placement, either at the bedside or in the radiology suite under fluoroscopic guidance, might be for those hemodynamically unstable patients that need access for acute PD.

In summary, peritoneal catheter placement by the modified Seldinger technique with fluoroscopic guidance takes the best peritoneal access candidates, the low hanging fruits, and subjects them to an inherently flawed procedure that produces marginally acceptable results. Because of the intrinsic danger of the procedure, the lofty fruits (patients with previous major abdominal surgery, gross obesity, and previous dialysis-related peritonitis) are excluded from consideration. Ignoring the high-hanging fruits and dropping many of the picked lower fruits should never be considered an optimal harvest in the orchard of peritoneal dialysis candidates.

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