New Peritoneal Catheters: New Catheter Problems?

Peritoneal access is the key to technique success in peritoneal dialysis (PD), and the peritoneal catheter is the “lifeline” necessary to the procedure. Although more than 50 years have passed since Tenckhoff described the permanent silicone peritoneal catheter with a polyester fiber cuff, his design remains the most widely used and the “gold standard” of peritoneal access.

Other designs and types of peritoneal catheters have been proposed to reduce catheter-related complications (1,2), including

- models based on the classical Tenckhoff design, with variations in the number (1 or 2) or shape (polyester fiber, disc-ball, and so on) of the cuffs, in the design of the tip (straight, coiled), and in the shape of the subcutaneous portion (straight or with a permanent bend).
- “named” models, with significant changes mainly in the intraperitoneal segment (the T-fluted Ash, the Lifecath, the Toronto-Western, the Ronco, and the Valli catheters) or materials (the Cruz catheter).
- new models, also based on the Tenckhoff design, but with functional modifications, such as the Vicenza “short” catheter (with a shorter intraperitoneal segment for a lower insertion that prevents dislocation and improves body image acceptance) or the Di Paolo self-locating catheter, with tungsten (12 g) attached to the tip for keeping it firmly in the Douglas pouch (3).

Each model has demonstrated advantages and disadvantages (1,4). The use of some models has been anecdotal; with other models, such as the self-locating catheter, use has spread (5,6). Here, we report some problems experienced with self-locating catheters.

METHODS

We retrospectively reviewed peritoneal catheter-related complications registered in our unit from 1996 to 2011. During that period, 129 patients (79 men, 50 women) were started on PD. Until 1996, we had been using straight Tenckhoff catheters with 1 or 2 polyester fiber cuffs. After that, we chose swan-neck double-cuff coiled catheters (TSNCs) with 5 cm between the cuffs (Tenckhoff Catheter 835: Fresenius Medical Care, Bad Homburg, Germany), described to have the advantages of less external cuff extrusion and a lower incidence of malfunction (3). In 2003, we began using straight, self-locating catheters (SLCs) with 6 cm between cuffs (Care-Cath: B. Braun Avitum Italy, Mirandola, Italy), which were placed with a slightly arcuate tunnel, with the aim of reducing episodes of catheter displacement. During the study period, 152 catheters (4 straight, 78 TSNCs, 70 SLCs) were implanted by the same nephrology team, using the mini-laparotomy procedure (open technique) for catheter insertion.

All patients were instructed to use saline solution for exit-site care, avoiding alcohol, iodine, or mupirocin, which were used only as adjunctive therapy for exit site infection.

RESULTS

Our aim of reducing episodes of catheter migration was confirmed, because the rate of catheter displacement has been very low since we began using the SLC. The dislocation rate declined to just 5.7% from 33% with the TSNC. Moreover, dislocations of SLCs are easily corrected with conservative measures that favor tip relocation, such as laxatives or jumping.

However, we have found some new problems with the SLCs:

- Disappearance of the radiocontrast line was observed in 2 catheters with a half-life of about 4 years. In the first patient, this situation caused a large number of alarms during the cyclor drain phase, attributable to collapse of the affected segment caused by machine suction. In the second patient (who was performing continuous ambulatory PD), the alteration did not cause problems until some time later, when the catheter developed a hole exactly where the white line disappeared (Figure 1). Similar events were not observed in TSNCs.
- Spontaneous extrusion of the subcutaneous cuff occurred in 10 catheters (14.2%), with no relationship to exit-site infection or trauma. In most cases, the event occurred in the first 3 months after implantation and was notorious for a total absence of granulation tissue on the extruded cuff. This complication occurred in only 2 of the TSNCs (2.5%).
- Breaks occurred in 5 of the SLCs (7.1%); no breaks were seen in the TSNCs. All cracks or holes (except the break that occurred in the catheter whose radiocontrast line disappeared) occurred very close to the outer cuff, under the skin [Figure 2(B)], and therefore should not be attributable to excessive use of corrosive disinfectants. In all cases, the clinical picture was similar: a finding of a late pericatheter dialysate leak, occasionally preceded by persistent exit-site infection. In 2 cases, we discovered multiple perforations in the subcutaneous intercuff segment after extrusion of the external cuff performed as a part of treatment for persistent exit-site infection [Figure 2(A)].
- Severe pelvic pain was present in 3 patients (4.2%) during the immediate post-implantation or training period. The catheter was functioning well and was well located, but the pain did not abate after dialysate was left in the peritoneal cavity. Two patients refused to initiate or continue with PD because of the severity

Figure 1 — Disappearance of the radiocontrast line: (A) Collapse of the catheter segment without the radiocontrast line. (B) Hole in the catheter where the radiocontrast line (white) disappeared.

Figure 2 — Catheter break. (A) Perforations in the subcutaneous segment are discovered after extrusion of the external cuff (thick arrow marks dialysate tears, fine arrow marks extruded outer cuff). (B) Subcutaneous catheter break (thick arrow marks grey line) close to the outer cuff (marked by fine arrow), visible after the catheter is pulled out.

Figure 3 — Skin ulcer at the external cuff (marked by arrows). (A) The catheter is visible through the ulcer. (B) The same catheter shown in Figure 2(B); dialysate is leaking through the ulcer.

of the pain. The third patient experienced alleviation of the pain after dialysis start. No similar picture was seen with patients using TSNCs.

- Skin ulcer at the external cuff was seen in 2 patients with a SLC (Figure 3).

DISCUSSION

After analyzing details of the SLCs that we use, we hypothesized some possible explanations for the particular problems we encountered.

- Unlike other catheters, in which the radiocontrast line is included in the silicone wall, the SLC has its radiocontrast line superimposed on the silicone wall. Superimposition explains the lesser thickness of the silicone at this point (to maintain catheter symmetry after the superimposition) and the easier “unsticking”

Figure 4 — The radiocontrast line. (A) Included in the thickness of the silicone swan-neck double-cuff coiled catheter, and (B) superimposed on the silicone in self-locating catheters.

of the line (Figure 4). The disappearance of the radiocontrast line makes the catheter more easily collapsible and more susceptible to be holed or broken at the site of the disappearance.

- The shape and glue used for the polyester fiber cuffs are different and coarser (Figure 5), which might explain the spontaneous outer cuff extrusion with its lack of granulation tissue and the catheter breaks in proximity to the cuff. We also wonder whether the glue might promote an inflammatory response, potentially favoring exit-site infection, skin ulceration, or even catheter damage.
- The “shape-memory” of straight catheters, in which the curved subcutaneous segment is not preformed, tends to straighten the catheter, favoring dislocation of the catheter tip because of its lightness and lack of fixation. On the other hand, repeated pulling of the catheter during bag exchanges, combined with the natural resilience of the silicone material, which gradually pushes on the external cuff, tends to extrude the cuff and straighten the arcuate tunnel. In fact, those were the factors that led to the design of the permanent bend in swan-neck catheters (7). A tendency to cuff extrusion in the first swan-neck prototypes (which were made of 80-degree arc angle tubing, with a distance of 8.5 cm between cuffs) was noted within several months after implantation, and those catheters were considered suboptimal. The excessive distance between the cuffs was implicated in the cuff extrusion rate. Swan-neck prototypes were replaced by modified swan-neck catheters, in which the distance between cuffs was shortened to 5 cm [Di Paolo and colleagues described his new catheter as having a distance of 5 – 7 cm between cuffs (8)] and the bend was increased from an 80-degree to a 180-degree arc angle. Results dramatically improved with this new swan-neck catheter design: cuff extrusion almost disappeared and usually occurred after exit-site infection and not because of catheter resilience. This was a notable reversal of the sequence of events with the previously used catheters, in which cuff extrusion usually preceded exit-site or tunnel infection (9).

The resilience (shape memory) of a straight catheter implanted in an arcuate tunnel plays the most important role in cuff extrusion (1). When weight is added to the tip of a straight catheter, some of the forces favoring external cuff extrusion might be counteracted because of the traction exerted by the weight of the tungsten, but the tendency of the “shape memory” to subsequently straighten the catheter at the outer (lightest) end might explain the frequency of spontaneous subcutaneous cuff extrusions (Figure 6).

- A possible explanation for the intense pelvic pain felt by some patients might be a tendency of the heavy catheter tip to cause decubitus ulcers or even perforations of soft tissues.

Some suggestions for potential improvements in the SLC design arise from the foregoing explanations: a change in how the radiocontrast line is included, addition of a permanent bend or arc (swan-neck), a change in the method of gluing the cuff, and lightening the weight at the tip.

Figure 6 — (A) The “shape-memory” of the unweighted catheter favors dislocation of the catheter tip because of its lightness. (B) A weight added to the tip of self-locating catheters favors straightening at the outer end.

Figure 5 — Differing shape and attachment of cuffs: (A) swan-neck coiled catheter and (B) self-locating catheter.

Experiences with the SLC have been published since 1996, mainly in Europe and frequently from Italian groups (8,10). We are therefore somewhat surprised that the complications we noted have not been reported to an extent similar to our experience. A study by Bergamin and colleagues from Switzerland reported an episode of severe tunnel infection without identification of a causative agent; we think that it might potentially be related to the polyester fiber cuff or even a catheter break. The same group reported 7 patients with pelvic pain (11). A multicentric study conducted in Italy showed a high incidence of drop-out from PD (7%) because of psychological distress (reason unspecified, but perhaps explained by pain) in patients using a SLC (12). Data from the Minguella group in Spain showed that 3.8% of SLCs were removed because of exit-site infection; no straight or coiled catheters were removed for that reason. The same group reported a significant incidence of "other problems" (not specified) that triggered SLC removal (13). We found no references to other atypical problems such as those experienced by our patients, perhaps because they were considered anecdotic.

To find an explanation for the problems we encountered, we analyzed the distribution of complications during the observation period. Problems such as disappearance of the radiocontrast line, catheter breaks, and skin ulcers were more frequent in the first implanted SLCs; they have not recurred, even in long-use catheters, until recently. That observation suggests that problems with certain batches play a role. (The relevant events were reported to the manufacturer, indicating the implicated batches.) The cuff extrusion rate did not significantly vary during the observation period, and extrusion is still a significant problem. Severe pain after implantation still occurs in some patients, but it is easily alleviated by leaving dialysate in the peritoneal cavity; no further patients have refused to initiate or continue PD because of severe pain.

We do not want to be unfair to the SLC, which has proved its efficacy reducing the frequency of catheter displacement. We bear in mind that some of the problems we have encountered might result from manufacturing defects in certain batches or even from our implantation technique; however, we believe it important to report these kind of incidents that might not be occasional or focused in a single center (14–16).

DISCLOSURES

The authors declare that no financial conflict of interest exists.

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doi:10.3747/pdi.2012.00336

METHODS