Optimizing Peritoneal Dialysis Catheter Placement by Lateral Abdomen X-Ray

A primary requisite for chronic peritoneal dialysis (PD) is an adequately functioning catheter. The ability of a PD catheter to deliver an adequate dose of dialysis is dependent on multiple factors, one of which is thought to be the position of the catheter tip (1). The optimal position of the catheter tip remains controversial (2,3), although it has been suggested that the catheter tip should be placed in the deep pelvic area to ensure optimal hydraulic function and to minimize the risk of omental entrapment (4,5).

Conservative measures like relieving constipation and changing the patient's body position are sometimes sufficient to improve dialysate flow, but if these simple procedures fail, patients may switch from automated PD (APD) to chronic ambulatory PD (CAPD) or undergo surgical intervention to reposition or replace the catheters (with or without partial omentectomy) (6).

We have carried out a retrospective study to determine whether there is any association between the position of the PD catheter tip and reported problems with drainage.

MATERIALS & METHODS

We retrospectively evaluated the electronic records of patients starting PD at The Royal London Hospital between 2 November 2009 and 17 March 2014. Peritoneal dialysis catheters were inserted using a "blind" Seldinger method, "open" surgical procedure, and laparoscopic technique (7) for subcutaneously "buried" catheters analogous to that described by Popovich and Moncrief (8). Catheters inserted using the Seldinger technique were placed under fluoroscopic guidance (anterior-posterior views); double-cuff coiled catheters were placed using Seldinger and "open" procedures (inserted mid-line 2 – 3 cm below the umbilicus) whereas swan-neck double-cuff catheters were "buried" with the insertion site paramedial at the level of the umbilicus. In all cases, the length of the catheter was selected by estimating the distance from insertion site to the top of the pubic symphysis as per International Society for Peritoneal Dialysis (ISPD) guidelines (9). For each patient, the catheter length was determined on the day of the procedure by the senior PD nurse, who had non-sterile catheters of different lengths available that were sized against the patient.

In November 2009, we introduced a policy to screen patients starting PD for abdominal aortic calcification. Patients undergoing PD training at The Royal London Hospital had a lateral abdominal X-ray as described by Martino, *et al.* (10). One of the investigators retrospectively reviewed these radiographs to determine the position of the PD catheter tip with reference to their pelvic brim. The position of the PD catheter tip was ascertained as either: i) below the pelvic brim or ii) above or at the pelvic brim (see Supplementary material for further details). The hospital started electronic patient records for

all PD patients since 2001. Details of all clinical encounters including physician and nursing clinic consultations were included in this database, which was reviewed by a different investigator (blinded) who determined the position of the PD catheter tip. Any reported drainage issues during the first 90 days of starting PD were recorded. We also recorded whether APD patients switched to CAPD because of drainage / alarm / ultrafiltration issues or whether surgery was required to reposition / exchange the catheter (with or without omentectomy).

RESULTS

We included 232 patients in our study: 66% males, mean age of 55.9 years. The PD catheter was placed using Seldinger, "open," and laparoscopic techniques in 123 (53%), 63 (27%), and 46 (20%) patients respectively. Lateral abdomen X-ray (AXR) revealed that 93 (40%) PD catheter tips were at or above the pelvic brim (malpositioned). The proportion of catheter tips that were "high" was dependent on the method of insertion: 46% of those inserted by Seldinger technique, 33% for those that used "open" or laparoscopic techniques ($p < 0.05$ by chi-square test), Table 1. Peritoneal dialysis catheter outflow problems were reported in 52 (22%) patients, although 26 cases were managed conservatively (i.e. 11% of PD catheters required surgical intervention or directly led to a switch to hemodialysis for flow problems).

Of the malpositioned catheters detected by lateral AXR, 30% had significant reported outflow drain problems. By comparison, if the catheter tip was below the pelvic brim on lateral AXR, drainage problems occurred in only 17% ($p < 0.02$ by chi-square test), Table 1.

DISCUSSION

Outflow or drainage failure is one of the most common causes of early technique failure in PD. It has been suggested that a catheter tip should lie in the true pelvis (9). Although we selected PD catheter length by estimating the distance from insertion site to the symphysis pubis, 40% of catheters were "high" on lateral AXR. Even though catheters inserted by Seldinger technique were placed under real-time fluoroscopic guidance, they were more likely to result in "high" catheter tips than catheters placed surgically

("open" or laparoscopic techniques). Invoices from the study period showed that we ordered equal numbers of 57.5-cm and 63-cm length catheters, and this was the same for catheters packed in "Seldinger kits" or "bare" (for open or laparoscopic insertion). Unfortunately, we did not record the length of catheter used for each patient, but it is interesting to speculate whether the inner cuff of surgically placed catheters were deeper in the subcutaneous tissue, resulting in the catheter being "pulled" into the pelvis. It is also possible that greater use of the longer 63-cm catheters (especially if inserted by Seldinger technique) could have reduced the number of "high" catheters.

Importantly, we have also demonstrated that patients with "high" PD catheters had statistically significantly higher rates of clinically important drainage problems (whether APD patients were managed conservatively by switching to CAPD or whether patients required surgical intervention or switched to HD). But the rates of surgical intervention were not different, probably due to the small study size.

We have reported on our single-center experience of PD catheter insertions and it may not be appropriate to extrapolate our findings and lessons to others. However, we have found that a lateral AXR appeared to provide more useful information about PD catheter tip position than the supine posterior-anterior view that we had during "blind" insertions. Unfortunately, we were unable to ascertain the angle of the intramural part of the PD catheter as described by Bammens et al., who showed that catheters whose angle was $> 30^\circ$ functioned better (3). But it is likely that our study would support their findings, as the final position of the catheter tip is a surrogate for the angle; caudal to exit-site distance = $\cos(\text{angle}) \times \text{catheter length}$. Whilst our study does not diminish the importance of the catheter angle, we highlight that selecting the appropriate length of the PD catheter to position the catheter in the pelvis is an inexact science and that we have generally underestimated the length required to position the tip within the true pelvis. Whether lateral AXR should be routinely performed is much more debatable although we have found it useful.

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TABLE 1
Position of PD Catheter, Method of Insertion and Drainage Problems

PD catheter position	No. of patients (<i>n</i> = 232)	Method of catheter insertion "Seldinger": "Open": Laparoscopic	No. of patients with drainage problems ^a (%)
At or above pelvic brim	93	57:21:15 ^b	28 (30.1%) ^b
Below pelvic brim	139	66:42:31 ^b	24 (17.3%) ^b

PD = peritoneal dialysis; APD = automated PD; CAPD = continuous ambulatory PD; HD = hemodialysis.

^a clinically significant drainage problems managed conservatively (by switching APD to CAPD) or by surgical intervention or if patient switched to HD.

^b p value < 0.05 by chi-square test.

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<http://dx.doi.org/10.3747/pdi.2014.00263>

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