Choosing the Most Appropriate PD Catheter by Preoperative Mapping
PD Nursing Fundamentals II
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by
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Since patients come in all sizes and shapes with a variety of medical conditions, one catheter type cannot be expected to fit all. The peritoneal dialysis access team, including the surgeon, interventional radiologist, nephrologist, and PD nurse, must be familiar with a basic inventory of catheter types to enable customization of the peritoneal access to the specific needs of the patient and to afford maximum flexibility in exit site location. A poor exit site location that the patient cannot easily see or take care of predisposes to exit site and tunnel infection. [1-4]

The most commonly employed PD catheter types are illustrated in Figure 1. The standard double Dacron (polyester) cuff, straight- and coiled-tip Tenckhoff catheters and their "swan neck" variants with a preformed arc bend in the intercuff segment comprise the core of PD access devices around the world (Figure 1 A, B). Extended 2-piece catheters were originally designed to create a presternal exit site (Figure 1 C). The extended catheter consists of a 1-cuff abdominal catheter segment that attaches to a 2-cuff subcutaneous extension segment using a double barbed titanium connector to permit remote location of the exit site to the upper chest, but can also be used to provide remote exit site locations to the upper abdomen. The 4 major catheter manufacturers in North America produce this basic inventory of catheters. Selection of catheter type should take into consideration the patient's belt line, obesity, skin creases and folds, presence of scars, chronic skin conditions, incontinence, physical limitations, bathing habits, and occupation. Depending on specific patient needs, peritoneal access can be achieved with at least one of the catheters shown in Figure 1. The primary difference among these catheters is that the coiled-tip configuration and the preformed arc bend increase the cost of the device. No significant difference in functionality has been demonstrated between straight- and coiled-tip catheters with or without a preformed arc bend.

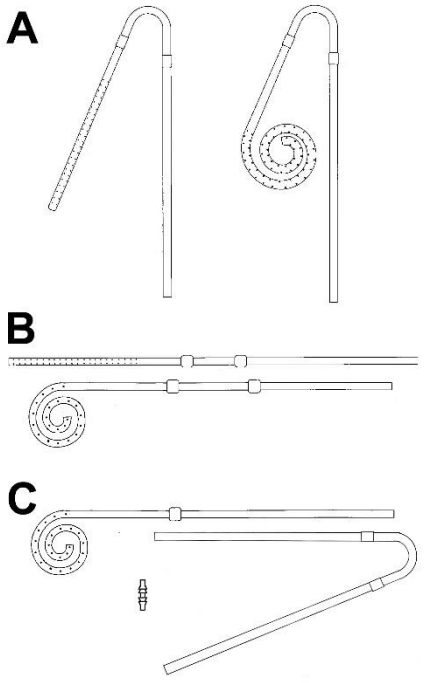

Figure 1. Shown are commonly used peritoneal catheters. A, Tenckhoff catheters with preformed intercuff arc bend, 2 cuffs, and straight or coiled or tips. B, Tenckhoff catheters with straight intercuff segment, 2 cuffs, and straight or coiled tips. C, Extended catheter with one-cuff, coiled-tip abdominal catheter, two-cuff extension catheter with preformed intercuff arc bend, and titanium double-barbed connector.

Often, hospital vendor contracts and purchasing agents determine the kind of peritoneal catheter maintained in stock. Moreover, the type of catheter provided is subject to change without notice. Considering current progress in peritoneal access technology, leaving catheter choice up to nonmedical personnel is unacceptable. The PD team must agree on a basic catheter

inventory and insist that these specific items are made available for the peritoneal access procedure. It is impossible for a PD program to develop a dependable protocol for catheter selection if the catheter types and dimensions are constantly changing. In addition, it is essential that each member of the PD access team understands and acknowledges that the preoperative mapping procedure described herein is a definitive and reproducible method that can be performed by any one of the team members for selecting the most suitable catheter type, insertion site, and exit site location.

Preoperative Mapping Using a Catheter Sample

The most appropriate choice of catheter is the one that produces the best balance of pelvic location of the catheter tip, exit site easily visible to the patient, and can be inserted through the abdominal wall with the least amount of tubing stress. The catheter insertion site is the fulcrum of this best balance and will determine the pelvic position of the catheter tip and the range of reachable exit sites. Therefore, catheter selection begins with determination of the insertion site. With the patient in the supine position, the insertion site for each style and size of catheter is determined by marking the upper border of the deep cuff in the paramedian plane when the upper border of the catheter coil is aligned with the upper border of the pubic symphysis (Figure 2). For straight-tip catheters, a point 5 cm from the end is aligned with the upper border of the pubic symphysis. If a straight-tip catheter design is preferred, choose a version that provides no more than 15 cm of length below the deep cuff to avoid having excess tubing crowded in the pelvis. During the catheter placement procedure, the deep cuff is implanted within the rectus muscle (or just below) at the level of the insertion incision. Using this convention to determine the insertion site will prevent the catheter tip from being implanted too low in the pelvis, producing pressure or poking discomfort, early termination of dialysate outflow, and severe end of drain pain. [5]

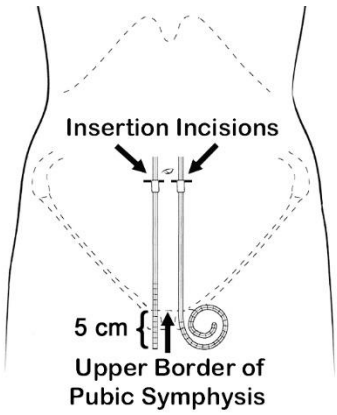

Figure 2. Schematic of a supine patient showing the manner in which the catheter insertion site and deep cuff location are selected in order to achieve optimal pelvic position of coiled- and straight-tip catheters.

After determining the catheter insertion site, the subcutaneous tunnel path and exit site location for catheters with a preformed swan neck bend simply follows the configuration of the tubing, marking the skin exit site 2 -3 cm beyond the superficial cuff. Catheters with a straight intercuff segment should assume a gentle arc in the subcutaneous tissues to produce more of a laterally directed exit site. To enable a gentle arc bend of the straight intercuff tubing segment, choose a catheter version with 5 to 6 cm between the Dacron cuffs. Illustrated in Figure 3 is a convenient 3-step algorithm for catheters with a straight intercuff segment to design a

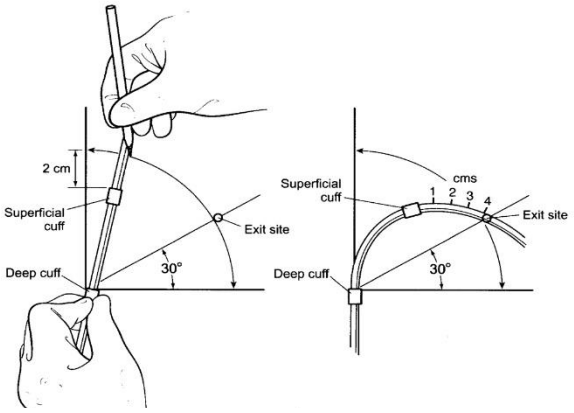

Figure 3. Three-step algorithm for lateral tunnel track and exit site design. Step 1: scribe arc from vertical to horizontal plane using catheter as compass from point 2 cm external of superficial cuff. Step 2: mark exit site at junction of medial 2/3rd and lateral 1/3rd of arc. Step 3: indicate tunnel track shape by bending catheter over from point 4 cm external of superficial cuff to exit site.

laterally directed tunnel and exit site that minimizes creation of excessive tubing stress and shape-memory resiliency forces that can lead to catheter tip migration and superficial cuff extrusion. The inherent properties of this algorithm prevent the superficial cuff from coming any closer than 2 cm of the exit site, even in the worst-case scenario of tube straightening.

If the catheter needs to be bent more than a laterally directed exit site, a catheter with a preformed swan neck bend should be used instead to eliminate these excessive forces. Upwardly directed exit sites should be avoided to prevent pooling of cutaneous bacteria and debris, perspiration, and shower water in the exit sinus, predisposing the patient to exit site and tunnel infection.

After mapping exit site locations, the patient assumes a sitting position and the marked exit sites are checked to see which is best visualized by the patient and does not conflict with the belt line, skin creases, or apices of bulging skin folds. If none of the marked exit sites for the standard abdominal catheters are satisfactory, the patient is then considered for an extended catheter to produce an upper abdominal or presternal exit site location.

Stencil-Based Preoperative Mapping

Marking stencils are provided by some dialysis catheter manufacturers for the most commonly used catheter designs. Properly constructed stencils contain critical catheter design information including the distance between the deep cuff and the coil, suggested subcutaneous tunnel configurations, and recommended exit site locations relative to the position of the superficial cuff. Additional features of a well-designed stencil plate permit its precise orientation on the trunk region according to fixed anatomical landmarks, such as the upper edge of the pubic symphysis, representing the anterior upper border of the true pelvis, and the anatomical midline of the torso. Stencils permit accurate and reproducible association of the catheter design elements to these anatomical landmarks to help determine the best catheter style and insertion site that will produce optimal pelvic position of the catheter coil and ideal exit-site location. In addition to the preoperative evaluation, the marking stencil is used again at the time of the catheter placement procedure to retrace the previously determined insertion incision, tunnel configuration, and exit site location. [6]

Figure 4 demonstrates use of a marking stencil to determine insertion site, tunnel track configuration, and exit site location for Tenckhoff-style catheters with a straight and preformed

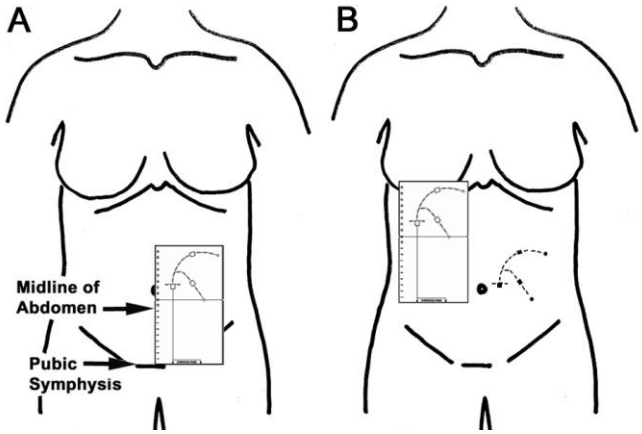

Figure 4, A. Mapping using stencil for Tenckhoff catheters with straight and swan neck intercuff segments. With supine patient, align medial border of stencil with midline of abdomen and stencil reference line for pubis with the upper border of the pubic symphysis. Mark exit sites for both catheter configurations. **B.** On day of procedure, mark cutouts for the insertion incision, tunnel configuration, cuff positions, and exit site location for selected catheter. It is sufficient to mark only the exit site cutout during preoperative assessment to select catheter type.

swan neck bend in the intercuff tubing segment. With the patient supine, the reference point toward the lower border of the stencil is aligned with the upper border of the pubic symphysis and the medial border of the stencil with the midline of the abdomen (Figure 4 A). During preoperative assessment for catheter selection, it is sufficient to only mark the prospective exit site. At the time of the catheter insertion procedure, the insertion site, tunnel track, and exit site cutouts on the stencil are marked (Figure 4 B).

Preoperative Mapping for Upper Abdominal and Presternal Catheters

Stencils are exceedingly helpful in determining optimal upper abdominal and presternal exit site locations. Mapping for an upper abdominal exit site begins with the patient in a sitting position. The stencil plate possessing cutouts for the secondary incision, tunnel configuration and exit-site is positioned over the patient's upper abdomen (Figure 5 A). Align the medial border of the stencil with the midline of the abdomen. Adjust the stencil cranially or caudally until the exit-site cutout is in a position that is easily visible to the patient, does not conflict with belt line or bra line, is free of skin creases or blind side of skin folds, and does not fall on the apex of a bulging or floppy skin fold. Confirm that cutouts for the subcutaneous arcuate tunnel do not conflict with the costal margin. After achieving a suitable location, mark the skin at the exit site cutout. If a suitable exit-site cannot be obtained, proceed to assessment for a presternal exit site location.

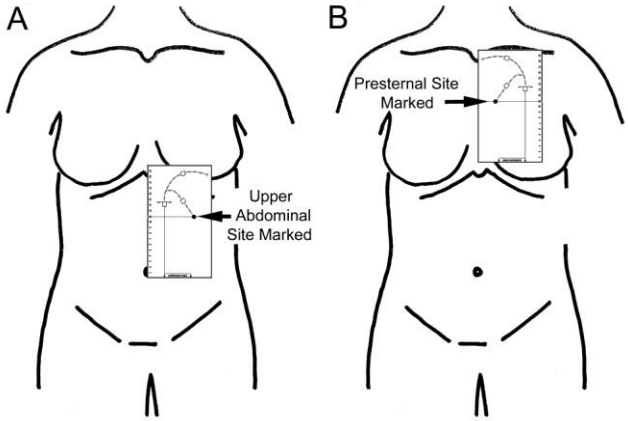

Figure 5. With the patient sitting, stencils can be used to select a suitable upper abdominal or presternal exit site. Only the swan neck bend pattern of the stencil is used for marking because all commercially available extended catheters are equipped with preformed arc bends. Note that the preformed arc bend is directed laterally for upper abdominal catheters and medially for presternal catheters.

Mapping for a presternal catheter exit site is performed with the patient in a sitting position. Female patients should wear their normal bra in order to note the point of rise of the breast mound. The stencil plate, possessing cutouts for the secondary incision, tunnel configuration and exit-site, is positioned over the patient's upper chest (Figure 5 B). Align the medial border of the stencil with the midline of the chest. Adjust the stencil cranially or caudally until the exit-site cutout is in a position that is not in the open collar area, does not conflict with a possible future midline sternotomy, is free of the fleshy or bulging part of the breast, and does not conflict with the bra line. Confirm that cutouts for the subcutaneous arcuate tunnel do not clash with the clavicle. After achieving a suitable location, mark the skin at the exit site cutout.

After a satisfactory upper abdominal or presternal exit site has been marked, the patient assumes a recumbent position. Female patients should remove the bra at this point to duplicate the conditions present during the catheter implantation procedure. Measurements are made, recording the horizontal distance from the marked exit site to the abdominal or chest midline and the vertical distance from the point of intersection of the horizontal line with the midline to a landmark such as the umbilicus for upper abdominal catheters or the jugular (suprasternal) notch for presternal catheters. Distinctive moles or scars also can be used as landmarks to locate the

exit-site. Measure and record the distance from the selected exit-site to these distinguishing marks.

Procedure Day Mapping

On the day of procedure in the preoperative holding area or operating room, the exit site is marked based upon the previous measurements. For standard Tenckhoff catheters, the stencil is superimposed over the denoted exit site and the cutouts for the subcutaneous tunnel, superficial cuff location, and insertion incision are marked (Figure 4 B). For upper abdominal and presternal catheters, after marking the exit-site and superimposing the exit-site cutout of the stencil over this point, the secondary incision, subcutaneous tunnel, and superficial cuff cutouts are marked (Figure 6). For upper abdominal and presternal catheters, the stencil for the lower abdominal segment of this 2-piece extended catheter is positioned on the abdominal wall. Align the medial border of the stencil with the midline of the abdomen. Adjust the stencil so that the mark for the pubis is superimposed over the palpated upper border of the pubic symphysis. Mark the primary incision site for insertion of the lower abdominal catheter segment (Figure 6).

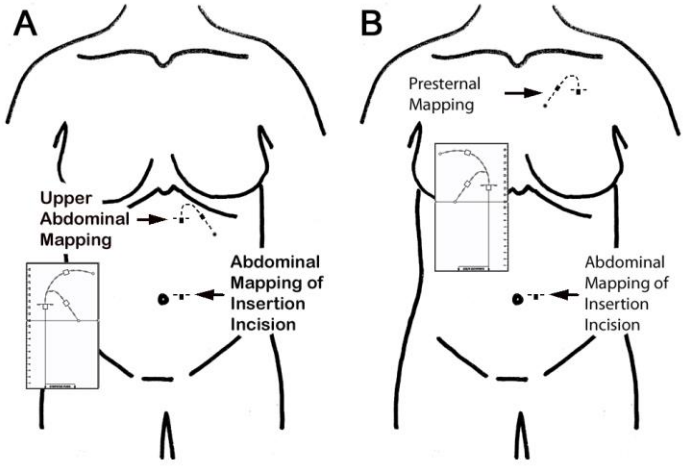

Figure 6 A. For upper abdominal catheters, the stencil cutouts for the secondary incision, tunnel configuration, cuff positons, and exit site location for the upper abdominal catheter segment are marked on day of procedure. In addition, a stencil is used to mark the primary insertion incision for the lower catheter segment. **B.** For presternal catheters, the stencil cutouts for the secondary incision, tunnel configuration, cuff positons, and exit site location for the upper chest catheter segment are marked on day of procedure. A stencil is also used to mark the primary insertion incision for the lower catheter segment.

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