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The Seldinger Approach to Percutaneous Nephrostomy and Ureteral Stent Placement

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Abstract. The Seldinger approach to percutaneous nephrostomy and ureteral stent placement involves needle-puncture, guide wire introduction, tract dilation and catheter placement as in angiography. We have used this approach on 101 obstructed renal units without significant complication.

Techniques are described in detail with special attention given to those for negotiating tortuous ureters. A guide wire through the kidney to the bladder can be used to place an indwelling stent either from above or below in order to free the patient completely from external appliances.

These techniques afford exciting new alternatives in the management of common urological problems. Most of all, they offer nonoperative palliation to terminal cancer patients and suitable alternatives to patients too ill to undergo surgery.

Key words: Percutaneous nephrostomy – Percutaneous ureteral stent placement – Indwelling ureteral stent placement – Ureteral stents – Interventional uroradiology.

In general, 2 different technical approaches to percutaneous nephrostomy have been described. One is angiographic, using the Seldinger technique of needle puncture of the kidney, guide wire manipulation, and catheter placement [1]. The other approach involves adaptation of various suprapubic cystostomy devices to percutaneous nephrostomy [2]. We have evolved an angiographic technique in our experience of catheterization procedures on 101 renal units in 67 patients between June 1977 and September 1980. No patient sent to our Radiology Department for percutaneous nephrostomy has left the department without diversion on at least one side. Many patients had multiple procedures after the initial nephrostomy, including tube replacement, tract dilation with insertion of a catheter with retention balloon, percutaneous ureteral stent placement (PUSP), and conversion of PUSP to an indwelling stent. Six kidneys in 5 patients had placement of multiple tubes at one sitting, in 5 to allow irrigation of the collecting system and in 1 for combined stenting of a ureteral fistula and urinary diversion. Ureteral stents were passed through operative nephrostomies in 3 kidneys in 3 patients. Twenty-one PUSP catheters were placed, and 5 of these were implanted subcutaneously. In 2 renal units a guide wire only was passed percutaneously through a ureteral stricture into the bladder. Fourteen indwelling stents were placed over a percutaneous guide wire.

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Percutaneous Nephrostomy

The most common indication for percutaneous nephrostomy is ureteric obstruction. External diversion can be lifesaving to patients too critically ill from uremia and/or sepsis to undergo any surgical intervention. A period of diversion may allow a urinary leak or fistula to heal. The nephrostomy tube can also

Table 1. Nonoperative supravesical urinary diversion

Failed retrograde ureteral stent placement
↓
Percutaneous nephrostomy
↓↑
Percutaneous ureteral stent placement
↓ ↓ ↓
Drain ↔ Cap ↔ Implant
↘ ↓ ↙
Indwelling stent
(from above or below)

0171-1091/81/0002-0141 $01.00

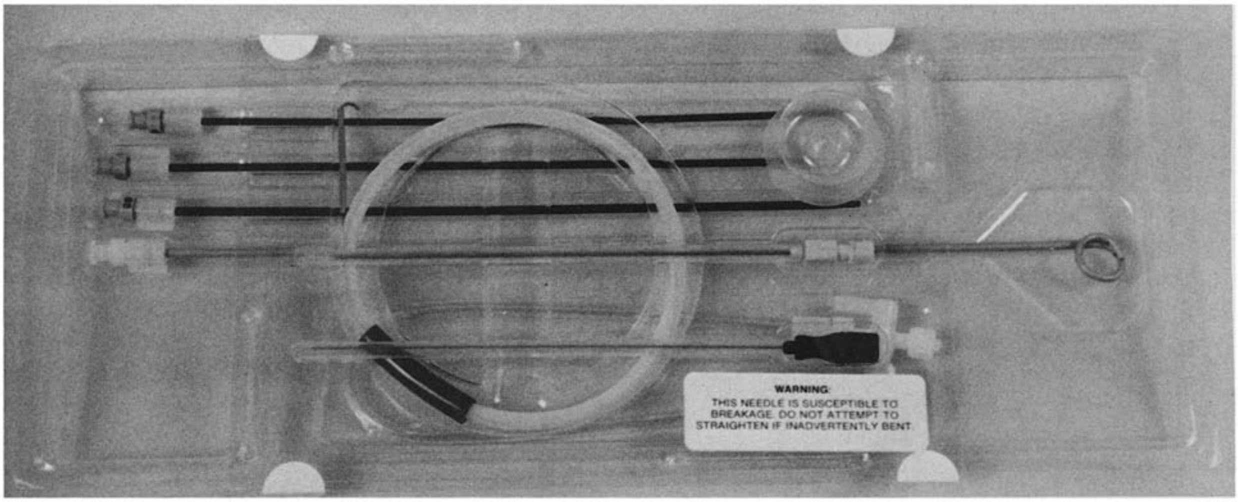

Fig. 1. Percutaneous Nephrostomy Set

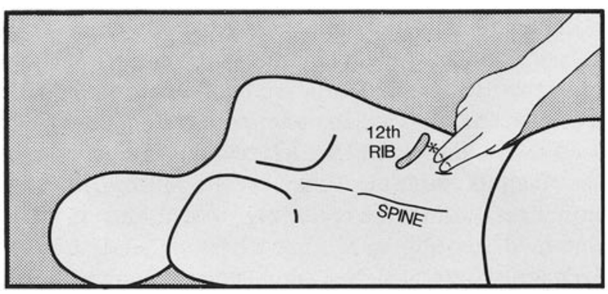

Fig. 2. Initial puncture in prone oblique position from a point 2 fingerbreadths lateral to the paraspinous muscle below the 12th rib directed at the center of the kidney

be used for irrigation with stone-dissolving solutions or antimicrobial or chemotherapeutic agents. The tube can be used to perform urodynamic pressure flow studies. The tube or tube tract can be used to insert stone or foreign body extraction instruments, brush biopsy devices, or even a nephroscope [2].

We now use a commercially available percutaneous nephrostomy set (PNS-1 Cook, Inc., Bloomington, IN) (Fig. 1). This convenient set contains all the equipment necessary to obtain safe, simple, ready access to a hydronephrotic kidney. We begin a nephrostomy with an antegrade pyelogram, using a 15 cm, 22-gauge needle from a posterolateral approach with the patient in a prone oblique position. The puncture site is 2 fingerbreadths lateral to the paraspinous muscles and below the 12th rib (Fig. 2). We have used ultrasound but prefer fluoroscopy for control because it allows precise cather positioning. With ultrasound for control rather than fluoroscopy, the skinny needle is used merely to sound for the kidney and contrast injection is not necessary. Since the hazard of contrast-induced renal failure is increased in patients with azotemia, we try to avoid intravenous contrast for visualization. It is not used unless the perirenal fat outline cannot be seen on the fluoroscopic monitor or on an overhead film and several needle passes have been made into the general area of the obstructed kidney without success. After urine is aspirated and collected for culture and sensitivity, enough contrast is instilled to visualize and distend the collecting system. No more contrast is instilled than the amount of urine previously withdrawn in order to prevent backflow and urosepsis.

If pyelogram needle placement is satisfactory, a 15 cm, 18-gauge trocar introducing needle is placed parallel to it and to the same depth. Otherwise, the introducing needle is placed where desired, with depth gauged by the first needle. In partially obstructed, leaking, or small collecting systems, contrast can be injected via the 22-gauge needle while the introducing needle puncture is being made. A 0.97 mm, 50 cm long J-tipped heavy-duty guide wire is next introduced through the 18-gauge needle so that the stiff portion is intrarenal. Placement of the guide wire tip down the ureter facilitates this positioning. Puncture in the mid-kidney opposite the pelvic ampulla facilitates ureteral placement (Fig. 3). After the needles are withdrawn, leaving the guide wire in place, the tract is dilated to 7 F over the guide wire. Serial dilation from 6 to 7 to 8 F may be necessary if the perirenal area is scarred from previous surgery.

An 8.3 F pigtail nephrostomy catheter with disc is next introduced over the guide wire. The catheter tip coils when it reaches the floppy portion of the guide wire. If this portion is intrarenal, so will be the final position of the catheter. The tip can be steamed to obtain a less coiled or even straightened configuration. Although ureteric position is prefered, the catheter tip can be coiled in the pelvis or calices. Puncture can be made in the lower pole and catheter

Fig. 3. In the ideal puncture, the guide wire is directed down the ureter

tip placed in the upper pole. When the desired catheter position has been obtained, the disc is then positioned and fixed at skin level and sutured to the patient. Because of the importance of securing the catheter adequately, we also suture the catheter directly to the patient's skin. The catheter is padded with slit sponges to prevent kinking at the skin. We tape the excess catheter in a coil, both to prevent kinking and for security. The urine is usually transiently bloody, sometimes up to 72 hours. If the urine appears to be hemorrhagic, we occlude the catheter before we begin the dressings. This procedure usually tamponades the bleeding by the time the patient is ready for discharge. The nephrostomy catheter is connected to a urinary drainage bag.

If nephrostomy drainage will be long term or permanent, we prefer to substitute a larger catheter with retention balloon over a guide wire. The Ingram catheter (Sherwood Medical, St. Louis, MO, Cat. # MAR 5670-12) works well. A siliconized Foley with its tip amputated or punctured with a 15-gauge needle works just as well and is much cheaper. The tube tract can be dilated at the first session. But since the patients are often quite ill, we prefer to wait 2 weeks. The interval allows a trial of diversion, further evaluation, and treatment planning. Also, internal diversion can then be attempted through a mature tract.

We have had no deaths, and morbidity has been minimal in our series. Our largest problem has been tube dislodgement, and that occurred mostly early in the series. Twelve tubes in 9 patients became dislodged with loss of urine flow. Two of these catheters were mysteriously removed by visiting nurses. Two were intentionally withdrawn by a self-destructive patient. Two patients developed urinary infections not present before tube placement, and 3 had extension of urinary infection present at the time of nephrostomy. Two of these had pyonephrosis with subsequent septic shock. Therefore, we minimize manipulation in the presence of infection. Two patients were found to have hematomas at subsequent surgery. Both patients presented technical problems that required multiple punctures. A common complaint has been leak of urine around the tubes. We believe this leakage is due to build-up of sediment in the tube so that it is easier for urine to exit around the tube than through it. Irrigation often clears the tube and solves the problem. Irrigation is advisable once a week. If the leak continues after irrigation, the tube is replaced with a tube of a larger size, such as a 10 F pigtail (Cook, Inc. Bloomington, IN, PNS-IA) or 12 French Ingram.

Percutaneous Ureteral Stent Placement (PUSP)

PUSP provides nonsurgical internal urinary diversion in the management of supravesical obstruction or urinary fistula [3]. The urine goes to its natural reservoir and no collection bag is needed. Ureteral cannulation from the flank is easily accomplished if the proper kidney puncture site is utilized. We prefer the mid-kidney site previously mentioned since the renal pelvis funnels the guide wire into the ureter from posterolaterally (Figs. 2 and 3). The recently obstructed ureter is fairly straight and cannulation is usually easy. The chronically obstructed ureter, on the other hand, is dilated and tortuous and often resists cannulation. Nevertheless, success can be expected in two-thirds of the cases.

We have found S-shaped ureters and distal ureters elevated by prostatic enlargement to be most troublesome. If the redundancy is short segment and not fibrosed or encased, a heavy-duty 0.97 mm, J-tipped guide wire will often advance through the segment, straightening it by pushing the redundancy forward until the ureter climbs up over the guide wire. Such a redundancy is usually in the proximal one-third of the ureter and accessible with a 50 cm guide wire. Distention of the ureter facilitates passage (Fig. 4). Advance of the guide wire may cause the ureter to fold on itself. If such a situation is encountered at initial nephrostomy, we leave the 8.3 F pigtail catheter coiled in or near the first loop of the ureter and try again in 2 weeks. A J-tipped guide wire advanced out of a straight catheter wedged in the first curve often traverses the first curve if the system is distended (Fig. 5A). This guide wire can be impacted in the second curve and pigtail inserted (Fig. 5B). The curved pigtail can be used to repeat the maneuver (Fig. 5C). The stiff portion of the guide wire will then straighten the S-curve. If the fully dilated system will allow, the J-tip can be engaged in the first curve so that the floppy portion of the guide wire folds over, presenting its loop to the second curve (Fig. 6). Gunther et al. [4] use a coaxial polyethylene catheter system of 5 F inside 7 F. Jander [5] recently described

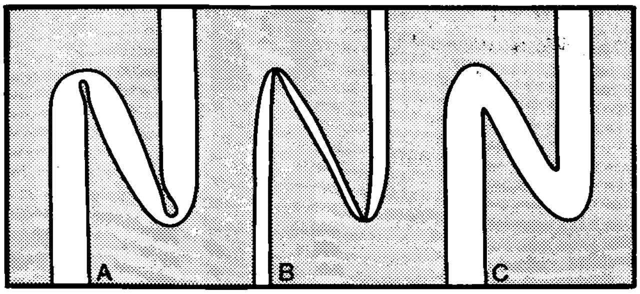

Fig. 4. **A** The S-shaped ureter. **B** The decompressed S-shaped ureter folds on itself. **C** The lumen opens with full distention

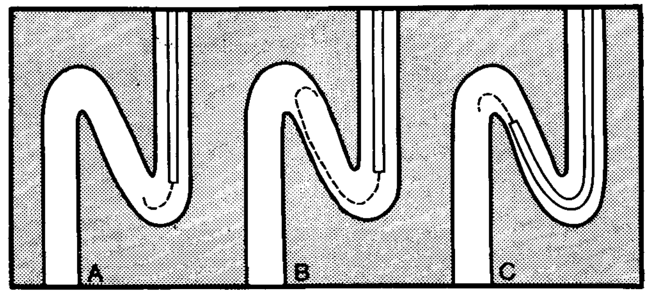

Fig. 5. **A** A J-tip can negotiate the first curve as it leaves a straight catheter. **B** The catheter follows the guide wire. **C** The procedure can then be repeated on the second curve

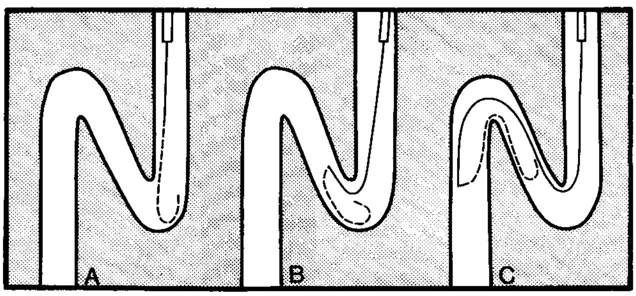

Fig. 6. J-tip wedged in first curve presents loop to second curve

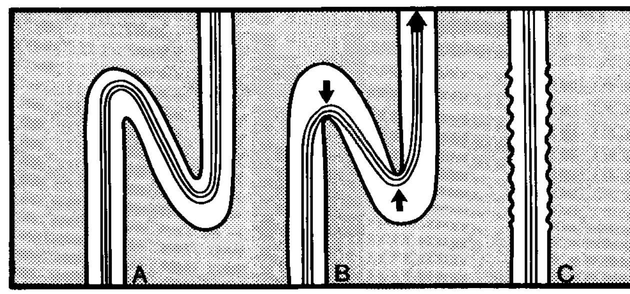

Fig. 7. A guide wire or small catheter wedged in the S curve can be pulled back to straighten the ureter. A steerable catheter in the first curve, held in curved position with the guide wire in the second curve, can be used the same way

a semirigid Flexible Coaxial Applicator System consisting of 5, 8, and 12 F Teflon tubing. We have used a similar system with success in S-shaped ureters. If a guide wire and coaxial catheter assembly can be wedged in the curve, sometimes the curve can be straightened by pulling back (Fig. 7). A steerable catheter curved and wedged in the first curve with a guide wire advanced beyond the second curve can be used to advantage in a similar manner. A guide wire deflector system can be useful in maneuvering J-shaped distal ureters from a prostatic enlargement. Any guide wire is manipulated only through a catheter or dilator in the kidney in order to protect the kidney from damage.

A streight, floppy, or movable core 0.97 mm guide wire is substituted for the J-tip when the level of stricture is reached. Before the straight guide wire is inserted, the catheter can be wedged in the stricture and contrast injected to define the residual pathway. Failure to visualize a residual lumen does not indicate the stricture is impassable. A catheter is advanced up to the stricture and the straight guide wire is used to probe gently, then more forcefully with a tapping motion. When the wire finds the residual lumen, a sudden cessation of resistance can often be appreciated. Surprisingly little resistance may be encountered even if the stricture lumen or the bladder cannot be visualized by contrast injection. If the guide wire cannot advance, it will buckle. The problem then becomes how to apply enough forward force at the tip of the guide wire to push through the stricture. Large, stiff guide wires such as described for biliary stent placement (Cook, Inc., Bloomington, IN, Lunderquist guide 5F 38 120, Lunderquist-Ring Torque guide HSF-38-125 THG) can be very useful in this situation. Also, large, stiff coaxial dilators such as those used in tract dilation or Dotter Transluminal Angioplasty (Cook, Inc., Bloomington, IN, CD-1 Dotter Transluminal Dilation Set) can be placed over the guide wire as far as the proximal ureter in order to splint the guide wire and transfer the force applied to the tip of the guide wire. A steerable catheter can serve the same purpose. Waiting 2 weeks after initial puncture for granulation along the tract can also be helpful.

After the guide wire has been passed, we usually dilate the stricture using an 8 F Teflon aortogram catheter (Cook, Inc., T-8 Aortogram). A 10 F steerable catheter can also be used for this purpose. For the actual ureteral stent, we usually use a 50 cm, 7.3 F polyethylene catheter with spiraled side holes over the distal 20 cm and a pigtail at its end. The spiraled side holes avoid the collection of a significant amount of stagnant urine between the stricture and the first proximal side hole. The pigtail is intended to coil in the bladder and both minimize irritation and resist migration back up the ureter. The pigtail can be omitted or removed if the catheter can be left above the ureterovesical junction. Reflux is then avoided. Side holes above the lesion allow urine to enter the catheter and flow into the bladder.

The catheter is secured to the skin like a nephrostomy tube. If the percutaneous stent is capped or otherwise occluded, the patient has been freed from a urinary drainage bag. The catheter end can be bandaged over and the patient can be fully ambulatory. Yet the catheter is readily accessible for irrigation or change. We have had a little experience with implanting the occluded catheter subcutaneously [6]. Although in 3 of the 5 implantations there were complications, all were avoidable and all were well managed by conversion to an indwelling stent. The applications of this technique may be limited, but we feel that it will benefit some patients. The subcutaneous catheter is quickly accessible for external diversion, irrigation, or tube change.

A guide wire alone passed percutaneously through the stricture can be used to aid the passage of an indwelling stent (Vance, Spencer, IN, part no. 03017) from below. A length of catheter serves as a pusher after the guide wire is brought out the urethra cystoscopically [7, 8]. A nephrostomy catheter can be placed over the guide wire and connected to drainage with the guide wire placed inside the drainage tubing. In this manner sterility can be maintained while the patient is being transferred from fluoroscopy to cystoscopy. The percutaneous guide wire can also be used to pass an indwelling stent percutaneously from above with a pusher [9], Care must be used to avoid a situation in which the distal catheter is hung up in the lesion and the proximal end is subcutaneous and beyond reach. Such a catheter could be retrieved with a snare or stone basket via nephrostomy [10]. A percutaneous stent passed out the bladder can be affixed to a Gibbon's stent. When the percutaneous catheter is pulled back out the flank, the Gibbon's catheter is pulled into place, stenting the stricture [11].

Table 1 diagrams our current approach to nonoperative supravesical urinary diversion. If internal diversion cannot be provided by cystoscopic retrograde ureteral indwelling stent placement, then external diversion is provided by percutaneous nephrostomy. An attempt is made to identify and stent the ureter to facilitate PUSP at the next sitting. We then allow the system to drain externally while the tube tract fibroses. The interval is useful to stabilize the patient, complete a thorough work-up, plan and initiate appropriate treatment. Reduction in tumor mass in the cancer patient may open the ureteral blockage and obviate the need for further percutaneous intervention. We exchange the nephrostomy tube for one with retention balloon if long-term external diversion is needed. If internal diversion remains preferable, PUSP is attempted. The stent catheter can be left to drain percutaneously if desired. It can be capped or otherwise occluded for trial of diversion. The catheter can be padded with gauze and left indefinitely. It is readily accessible for irrigation or change should it become blocked. It can provide external diversion should the bladder become replaced by tumor and no longer function as a reservoir. In some patients it may be desirable to implant the proximal tip of the catheter subcutaneously in the flank. From above or below, an indwelling stent catheter can be placed over a percutaneous guide wire for optimal long-term management.

This approach allows us maximum versatility in the management of each patient. It can allow chemotherapy or irradiation to control primary malignancy while maintaining convenient home care. These percutaneous techniques offer nonsurgical alternative therapy for patients who are otherwise unacceptable surgical candidates. Their safety and convenience make them the procedures of choice in many circumstances. There is no need for a patient to undergo operative nephrostomy except during another operative procedure.

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