Interventional Procedures in the Upper Urinary Tract

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Abstract. The introduction and acceptance of percutaneous nephrostomy as a safe and effective alternative to surgical nephrostomy serves as the impetus for the development and expansion of an ever-increasing number of techniques that are encompassed by the term "interventional uroradiology." This article reviews many of the nonvascular interventional techniques that have proliferated during the past decade and that are currently used in the kidney, ureter, and perinephric space. The authors emphasize those procedures that are most frequently employed, as well as their own preferences and perspectives on these procedures.

Key words: Interventional procedures, genitourinary system, kidney, ureter—Abscess, kidney—Biopsy, kidney, ureter

The 1980s witnessed a remarkable proliferation of interventional radiological techniques, most of which supplanted existing forms of surgical management and improved patient care. This article reviews the nonvascular interventional procedures that have been applied to diseases of the upper urinary tract. The relatively large experience with these techniques that we and others have been able to gain during the brief span of a decade attest to their wide applicability, safety, and effectiveness, as well as virtually universal acceptance by both clinicians and patients.

Renal Cyst Aspiration and Ablation

Diagnostic renal cyst aspiration with cytological evaluation of the fluid and a radiographic cystogram was one of the most frequently performed percutaneous studies in the 1970s. For many radiologists it served as both introduction to and initial training for urinary tract interventional procedures. However, with the advent of ultrasonography (US) and computed tomography (CT), modalities that made it fairly easy to assure that a renal cyst was benign, the need to needle such lesions nearly vanished. Today, renal cyst aspiration is only performed on rare occasions when US or CT cannot definitely establish that a renal cyst is benign [1]. Small cysts close to the renal hilum that cannot be definitively imaged with US, CT, or fluoroscopy are usually best left undisturbed for fear of inadvertent injury to adjacent major renal vessels.

To study a cystic renal mass, a 20-gauge needle is inserted into the lesion with ultrasonic or, less commonly, CT guidance, approximately half of the estimated cyst volume is removed, and it is replaced with an equal volume of a combination of water-soluble contrast material and air to produce a double-contrast image. The mass is then examined in multiple projections with both horizontal and vertical x-ray beams. A simple cyst must exhibit a smooth inner wall without mural nodules or wall irregularity (although wall undulation where a cyst abuts renal parenchyma, a calyx, or blood vessel is acceptable). Masses with wall irregularity or fixed filling defects, or those that harbor malignant cells, probably represent cystic neoplasms and should be surgically explored. If no fluid is forthcoming, the aspirate should be examined cytologically, nonetheless, and multiple aspirations are probably warranted.

A typical benign cyst contains cytologically negative, clear, amber-to-yellow colored fluid that is chemically akin to a plasma transudate. If a cyst contains proteinaceous fluid, instillation of contrast may cause a foamy, frothy appearance which may make it difficult to exclude the presence of masses within the cyst [2]. Hemorrhagic or infected cysts...
often contain dark, cloudy or blood-stained fluid, but should have a smooth lining and negative aspirate cytology. Once a renal cyst has been punctured, its wall can thicken and even calcify, making subsequent radiologic evaluation difficult [3].

Complications of diagnostic renal cyst aspiration occur in 2–4% of cases [4] and include pneumothorax (when an upper pole cyst is punctured), hemorrhage from vascular injury, and infection. Transient hematuria is a frequent innocuous finding if the renal parenchyma was traversed.

Percutaneous ablation of a benign renal cyst is indicated if the lesion is causing pain, obstructive hydronephrosis, renin-dependent hypertension due to vascular compression and segmental ischemia, pressure atrophy of adjacent parenchyma, or proteinuria from renal vein thrombosis. In patients in whom an association between flank or abdominal pain and a sizeable renal cyst is suspected, we favor percutaneous drainage of the cyst in question. If the pain subsides but subsequently recurs in conjunction with reaccumulation of cyst fluid, percutaneous sclerotherapy is undertaken. Our experience has been that most such associations are fortuitous, and not cause and effect.

If a cyst is to be ablated, a small pigtail catheter is placed in the lesion, a diagnostic study is performed (if it has not been carried out previously), the majority of the cyst fluid is aspirated, and a sclerosing agent is instilled under fluoroscopic control. A variety of agents have been used to permanently obliterate a symptomatic cyst. Some are left in the cyst (e.g., Pantopaque, quinacrine), but most water-soluble agents (e.g., alcohol, tetracycline) are instilled for only 10–20 min and then aspirated. The volume of water-soluble sclerosant varies with the agent employed. In general, 25–50% of the cyst volume should be replaced for permanent obliteration of the cyst lining [5]. With a catheter in place, the patient can be turned to bring the sclerosant into contact with the entire cavity. At the end of the procedure, the agent is completely withdrawn and the catheter is flushed with saline prior to its withdrawal.

The most popular (and safest) sclerosing agent at present is 95% ethanol (alcohol). Alcohol fixes the epithelial lining cells and renders them nonviable in 1–3 min. Penetration of the cyst capsule requires contact times of 4–12 h [5]. In one series, 33 of 34 cysts treated with intracystic alcohol for 10–20 min were successfully obliterated [5] (Fig. 1).

Retroperitoneal extravasation of sclerosing agents can cause an inflammatory reaction with fever, fat necrosis, or soft tissue fibrosis, so it is important to exercise care during sclerosant instillation and subsequent catheter withdrawal. If a cyst to be ablated communicates with the renal collecting system on initial diagnostic opacification, a sclerosant should not be injected as it may cause fibrotic strictures of the pyelocalyceal system. A case in point is the large calyceal diverticulum mistaken for a renal cyst.

Nephroscopic resection or fulguration of benign renal cysts through percutaneously created tracks, as well as percutaneous marsupialization of a cyst into the collecting system following unsuccessful ablation therapy have been described [6–8].

Percutaneous Nephrostomy

The introduction and acceptance of percutaneous nephrostomy (PCN) as a safe and effective alternative to surgical nephrostomy served as the impetus for the development and expansion of an ever-increasing number of techniques that are encompassed by the term “interventional uroradiology.” PCN has become an indispensable part of the diagnosis and management of a wide variety of urologic problems. Most cases that benefit from PCN fall into one or more of the following categories of need.

Providing Urinary Drainage for Relief of Renal or Ureteral Obstruction

This is necessary when endoscopic retrograde attempts to drain the obstructed kidney are not feasible, expedient, or possible. Here, PCN serves to

![Fig. 1. Percutaneous sclerotherapy for renal cyst. A Excretory urogram performed for left flank pain shows evidence of a central renal mass which is upwardly displacing the renal pelvis and obstructing the proximal ureter (arrow). Nephronogram shows this to be a benign parapelvic cyst. The cyst was percutaneously drained with relief of the patient’s symptoms as well as the obstruction, both of which recurred as cyst fluid subsequently reaccumulated. B Excretory nephrotomogram 2 years following repeat cyst aspiration and instillation of Pantopaque shows oily contrast in a small residual cyst and resolution of obstructive uropathy. The Pantopaque, a sclerosing agent, continued to be reabsorbed on subsequent follow-up.](image)

![Fig. 2. Percutaneous nephrostomy for endopyelotomy. Patient with failed ureteropyeloplasty for congenital UPJ obstruction and pigtail catheter in surgically created lower pole nephrostomy track presents for creation of new nephrostomy track to allow for endoscopic incision of residual stenosis. A 5F ureteral catheter passed cystoscopically into renal pelvis. Air pyelogram visualizes posterior interpolar calyx (arrows). This calyx would have been easily seen had positive contrast material been injected with the patient in the prone position. B Nephrostomy needle inserted into targeted calyx with injection of positive contrast. C Percutaneous insertion of 6F ureteral access catheter for subsequent nephrostomy track dilation and endopyelotomy.](image)