Percutaneous Nephrostomy, Antegrade Stent Placement, and Radiological Control of Post-PCNL Bleeding

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Abstract

Percutaneous nephrostomy is a well-established technique for relief of obstruction of the renal outflow tract. The technique can be extended into nephrolithotomy for stone removal, nephroscopy, ureteroscopy, and antegrade ureteral stent placement. Serious vascular complication can be avoided by entering the pelvicalyceal system from relatively avascular area under radiological guidance.

The puncture site can be from the lower pole, interpolar region, or upper pole, depending on the indication for which nephrostomy is being performed. Appropriate entry requires proper visualization of the collecting system, which is optimum whenever there is hydronephrosis.

Puncturing a nondilated system is difficult and associated with a higher complication rate.

Transient hematuria, which is mostly managed conservatively, occurs in virtually every patient after percutaneous nephrostomy; however, severe bleeding that may require transfusion or intervention is uncommon. Other complications that may be seen include urosepsis, which can be avoided by minimal manipulation and protective antibiotic cover.

Knowledge of basic technique of nephrostomy and its complications is therefore very important; it allows the operator to extend the technique with safety, whenever required.

Keywords

Percutaneous nephrostomy • Stenoses • Drainage • Antegrade nephrostomy • Ureteral stent • Percutaneous nephrolithotomy • Hemorrhagic complication • Embolization

Percutaneous Nephrostomy

Percutaneous nephrostomy (PCN) has been in clinical practice for urinary diversion in patients presenting with obstructive uropathy for more than 40 years. Fernstrom and Johannson reported the first percutaneous nephrostomy in 1976 [1]. The principles applied to percutaneous puncture for nephrostomy apply equally well to percutaneous nephrolithotomy (PCNL), which has now become an established technique for renal stone removal [2]. A similar percutaneous approach can also be used for placement of antegrade double-J stent (DJS) in patients for whom the retrograde insertion is difficult or has failed. The major indications for percutaneous nephrostomy include urinary diversion in obstructed system, urinary leak or fistula management, renal stones, urosepsis, antegrade DJS placement, and nephrostogram examination [2].

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Anatomy

Precise understanding of perirenal anatomy is essential prior to performing PCN to avoid injury to other organs. Kidneys are retroperitoneal and are surrounded by perirenal fat and Gerota's fascia. A clear understanding of the renal vascular anatomy also allows the operator to avoid vascular complication associated with percutaneous nephrostomy. The renal artery divides into major anterior and posterior branches, which creates a zone of relative avascularity between the divisions (known as *the Brödel's bloodless line of incision*) that lies just posterior to the lateral convex border of the kidney. The optimal entry plane lies posterolaterally, at the junction of the anterior two-thirds and posterior one-third of the kidney [3, 4]. The renal artery and the renal vein are fortunately situated anterior to the renal pelvis; however, the posterior branch supply for the dorsal segment runs behind the renal pelvis.

A percutaneous nephrostomy tract that enters the pelvis through a calyx has the least possibility of causing arterial injury. It is important to realize that puncturing directly into the renal pelvis is to be avoided, as the risk of hemorrhagic complication increases by this approach. It is recommended to puncture the posterior calyx, which can be identified easily on ultrasound (US) and computed tomography (CT) scan. However, if the approach is under fluoroscopy after intravenous/retrograde contrast injection, the calices that appear end on are posterior [5]. Other structures and their relationship with the kidney are important to recognize for safe and uneventful percutaneous nephrostomy placement. Use of Doppler ultrasound can provide additional information; however, it is not mandatory particularly for experienced operator.

While gaining percutaneous access for nephrostomy, an important consideration is the pleural space that extends posteriorly down to T_{12} vertebral body level. On the left side, the descending colon is anterior in relation with the left kidney, but in approximately 1 % of patients, it may be present behind the kidney [5]. This may result in a serious complication, of colonic injury, particularly in PCNL, if access is under fluoroscopic guidance alone. Ultrasound helps in recognizing the presence of retrorenal colon.

Techniques

Patient Preparation

Before starting this procedure, the patient must be screened and, if required, treated for coagulopathy. A review of the patient's complete medical record will help in planning the nephrostomy approach and in identifying any variant anatomy. Prophylactic antibiotics should be administered before the procedure and continued according to the patient's condition [6, 7].

Informed consent must always be obtained and should follow on a discussion prior to the procedure, which explains the indications for doing the procedure, use of anesthesia, and potential complications that can be encountered [2, 6].

The patient is then placed in a prone position on the fluoroscopy table with rotating C-arm facility, along with ultrasound scanner. Some interventionists prefer placing a 45° foam pad to elevate the side where the nephrostomy is to be done [2, 5]. Under US guidance and local anesthesia, the puncturing needle (21–18 gauge), depending on operator experience and preference, is advanced into the dilated collecting system (using Seldinger technique). After this the procedure is done under fluoroscopic guidance. The contrast is injected to outline the collecting system followed by placement of a guide wire (0.018–0.035 in.). Various guide wires may be used in different situations (Fig. 54.1), *Amplatz Super Stiff wire* (short, straight tip with stiff wire), *Bentson Starter wire* (tapered floppy tip forms a J when advanced, but can also be advanced through stenoses in straight format), glide wire (hydrophilic-coated nitinol with polyurethane coating, excellent tortuous tracking), and *Lunderquist Extra Stiff wire* (malleable tip with stiff wire). Some of these are used for vascular access as well.

Serial dilatation over the guide is achieved, and a nephrostomy catheter is then passed over the guide wire and placed ideally in the renal pelvis. The guide wire is then removed, taking care not to displace the catheter. The external surface of the nephrostomy catheter is secured to the skin with sutures, and then a sterile dressing is applied. It may sometimes be necessary to make the initial puncture under CT scan guidance (Fig. 54.2) when there are technical difficulties, especially when the patient is obese or has severe scoliosis, making the procedure difficult and risky under ultrasound or fluoroscopy [5].

Post-placement care of the nephrostomy catheter is important (Fig. 54.3a, b). The catheter is normally left for temporary drainage; however, whenever it is to be kept for longer duration, it should be exchanged every 3–6 months (over a guide wire) to avoid encrustation and occlusion [2].

Complications of percutaneous nephrostomy can be characterized as minor or major. Minor complications requiring no treatment occur in 15–25 % of procedures and include minor bleeding that gradually resolves [3, 4, 8, 9]. The mortality for percutaneous nephrostomy that has been reported in the literature is 0.46–0.3 % [4, 9, 10]. Transient hematuria is frequently seen and requires conservative management. However, incidence of major hematuria is 1–3 % [10].

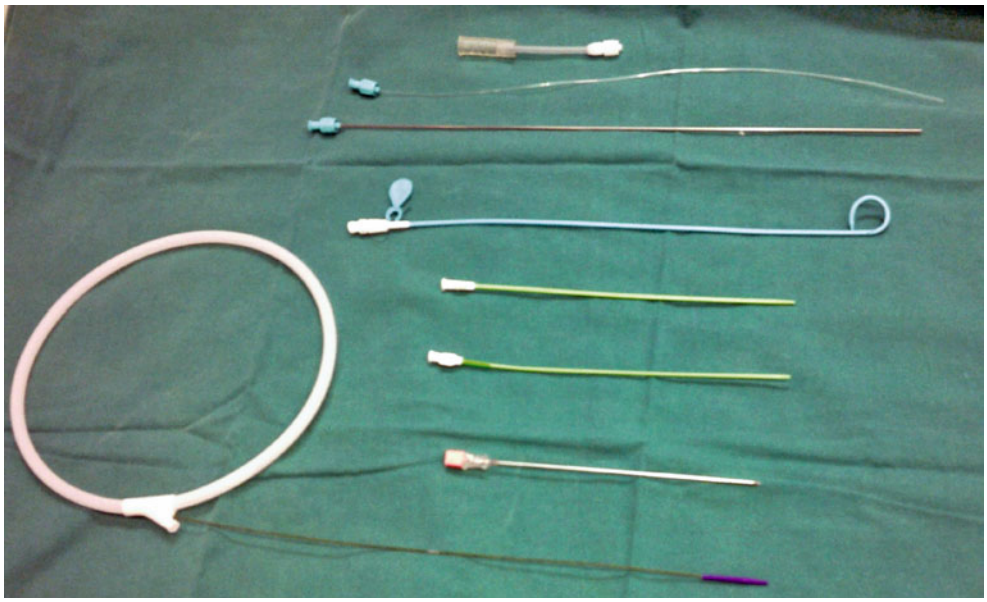

Fig. 54.1 PCN set with 0.038 guide wire, puncture needle (18 G), dilators 6 and 8 Fr, 8-Fr locking nephrostomy catheter, stiffeners, and connector

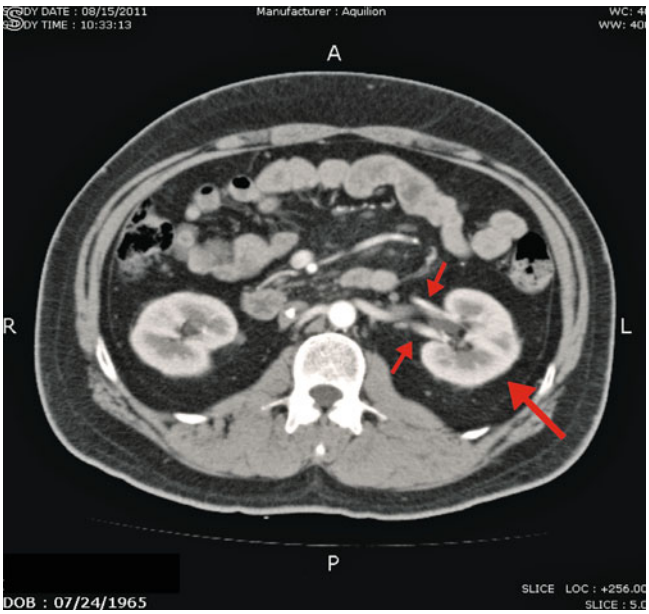

Fig. 54.2 CT scan image showing the left renal artery dividing into anterior and posterior branches marked by the *smaller arrows*. The *larger arrow* signifies relative avascular area

Antegrade Ureteral Stent Placement

Percutaneous nephrostomy can be extended into antegrade ureteral stent placement. It is reserved for those cases in which either the retrograde attempt had fail or was not feasible [2].

Ideally, the decision for antegrade stent placement should be made at the time of percutaneous nephrostomy, as the puncture site should be at the interpolar or upper polar region [2], which will have an impact on renal pelvis access and provides a straighter course for antegrade ureteral stent placement.

Techniques

The technique for antegrade ureteral stent placement is the same as described in the section for nephrostomy, keeping in mind the entry into the dilated collecting system via the interpolar or upper pole calyx. After puncture and placement of guide wire, a vascular access sheath is placed (usually of size 7 Fr), which will facilitate catheter and guide wire exchange, as well as the contrast injection required during the procedure.

Through the sheath a simple curved catheter (5-Fr C1 catheter, Cordis) is introduced along with hydrophilic guide wire (Terumo). The catheter is advanced to the site of stricture, which is then manipulated with the help of hydrophilic wire. The anatomy is initially outlined by injecting contrast via the sheath. The stricture is usually successfully negotiated by this technique; however, if the stricture is not crossed after multiple attempts, it can be reattempted after a 5–7-day interval of external drainage, which allows mucosal edema and ureter redundancy to resolve [5].

After negotiating the stricture, the guide wire is advanced into the bladder, followed by advancing the catheter into the bladder, over which the exchange wire (Amplatz Super Stiff) is also placed into the bladder. The stricture may need to be dilated with an angioplasty balloon—usually a 3–4-mm

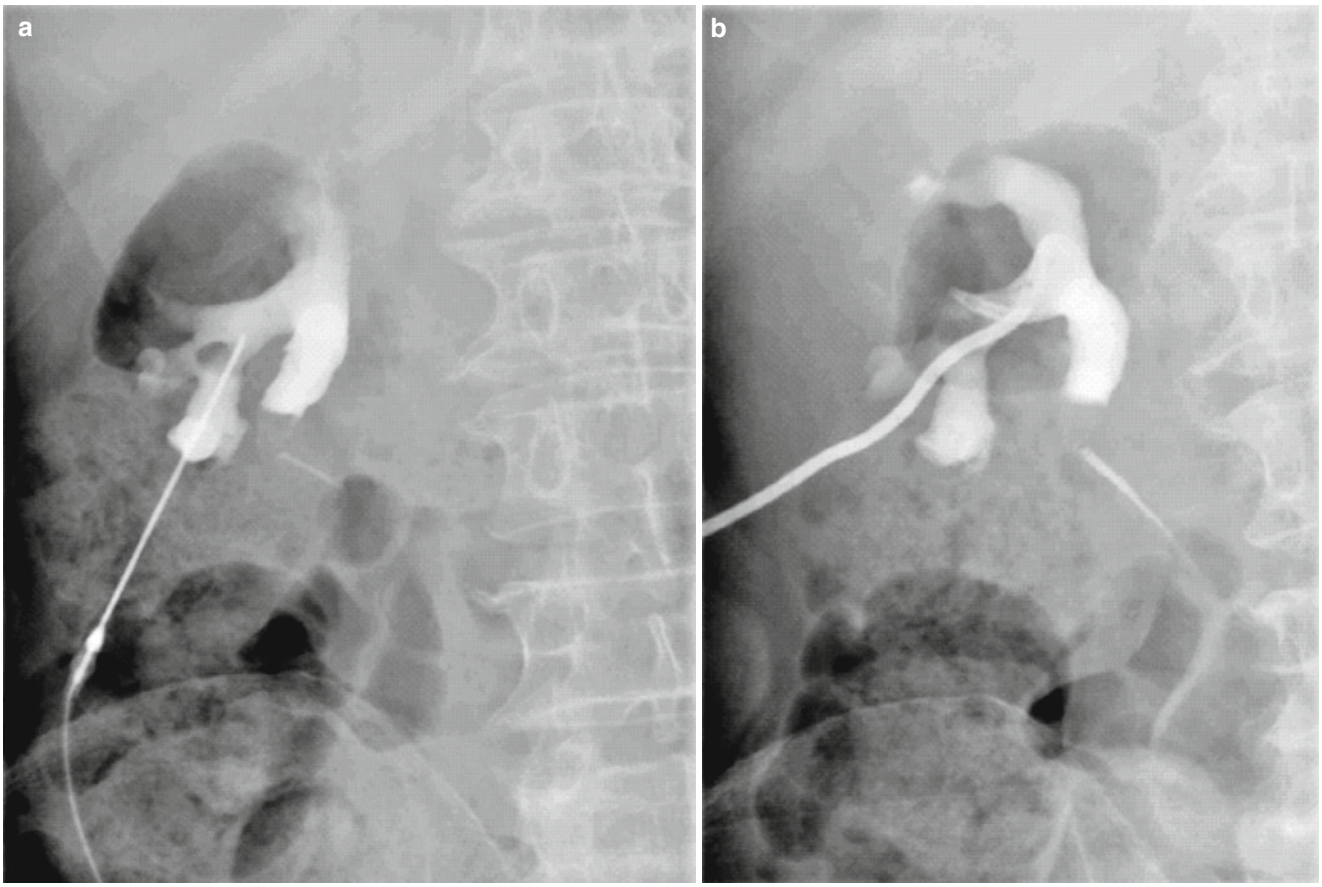

Fig. 54.3 (**a**) Fluoroscopic image showing needle in place while doing (**b**) percutaneous nephrostomy and subsequent nephrostomy catheter placement. Note the collecting system is opacified by contrast

angioplasty balloon is required for this purpose [5]. After the balloon dilatation has been done over the super stiff wire, the stent is deployed with the help of the pushing catheter. Usually 22–24-cm-length stents are suitable in majority of these patients. The distal loop of the catheter should be carefully deployed inside the bladder and should not be excessively advanced, as such may cause bladder irritation [2]. The guide wire is gradually and carefully withdrawn. The proximal end is then advanced with another catheter (the "pusher") to form a coil in the renal pelvis. Sometimes it may be required to slightly withdraw the sheath to make a coil of proximal loop of the stent. For safety, temporary nephrostomy drainage is instituted. The guide wire is reintroduced and coiled into the renal pelvis; a nephrostomy catheter is then advanced over the guide wire. The external drainage can be clamped after 24 h followed by nephrostogram to document stent patency. On confirmation of the patency, the nephrostomy catheter can be removed [2].

Ureteral stents have few complications, among which stent occlusion is the most frequently seen due to encrustation. Long-term patency can be achieved by encouraging the patient to maintain high fluid intake. Stent patency varies from 2 to 18 months [5]. Trimonthly evaluation of these patients is recommended; if stent occlusion is suspected, either ultrasound or cystogram examination should be ordered. The stent is to be exchanged at 6 months.

Other complications described include improper position of stent, ureteral perforation, stent migration, stent fracture, ureteric wall ischemia, urinary tract infection, and bladder irritation.

Hemorrhagic Complication of PCNL

Transient hematuria occurs in virtually every patient after PCNL and is managed conservatively. Significant hemorrhage requiring transfusion occurs in 1–3 % of the cases [2]. Major arterial injury is seen in about 0.5 % cases [5]. This should be suspected whenever gross hematuria persists for 3–5 days, with new clots demonstrated in the collecting system upon a follow-up nephrostogram, and when an accompanying drop in hematocrit is observed. These patients should be evaluated by angiography with embolization whenever possible. While performing angiography, renal

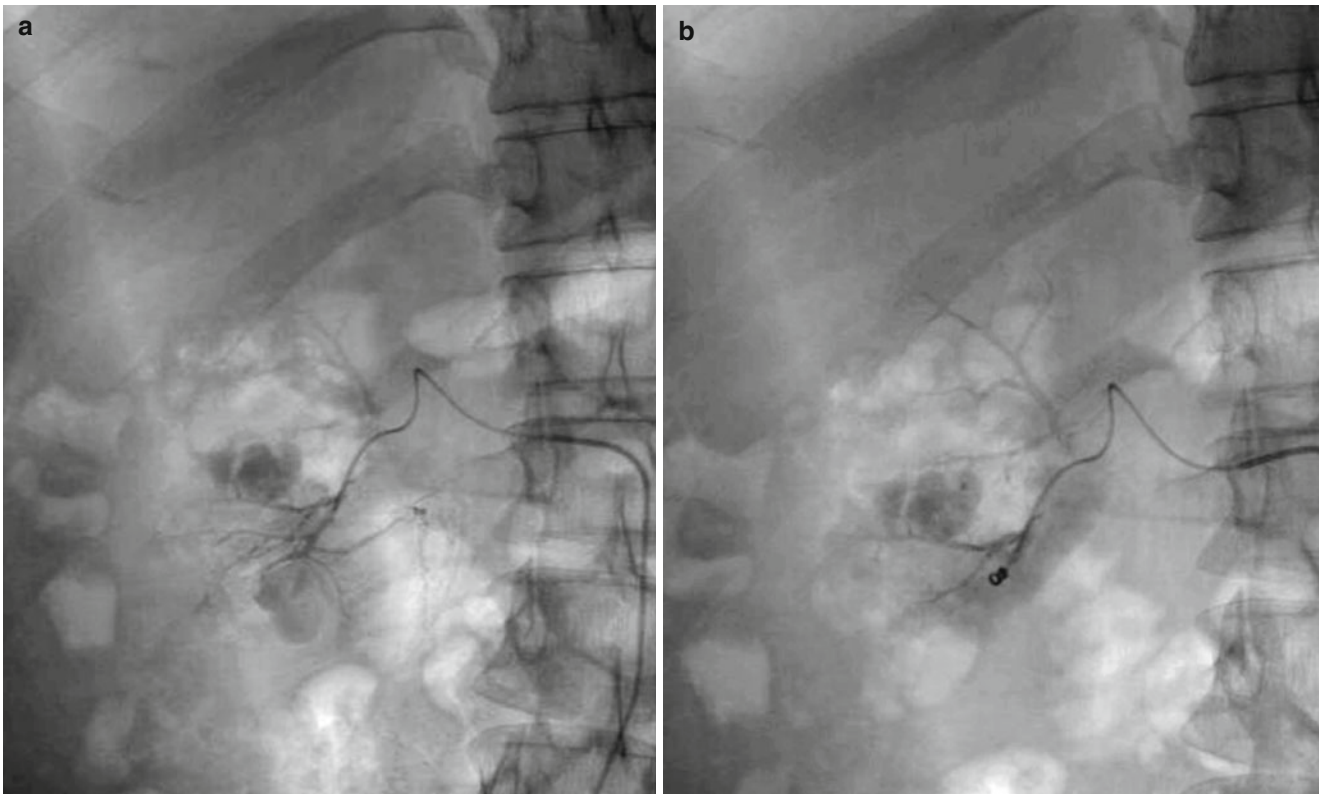

Fig. 54.4 (**a**, **b**) Pseudoaneurysm after PCNL, which was superselectively cannulated and embolized with microcoil

arteriovenous fistula, pseudoaneurysm, and/or vessel laceration are the major vascular complications that can be detected and subsequently embolized [2].

After doing a selective angiogram of the main renal artery, the region where intervention was done should be evaluated carefully with microcatheter technique. A microcatheter is introduced via a coaxial approach, and the abnormal vessel is identified by superselective cannulation and subsequently treated with embolization with coils [11–14] (Fig. 54.4a, b).

Conclusion

Minimally invasive radiological techniques have been established as safe and reliable treatment options in patients with obstructive nephropathy. The technique can be utilized in the primary management of these patients with excellent outcome. Simple nephrostomy can be extended for placement of antegrade ureteral stent in patients for whom retrograde stent placement was unsuccessful. It can further be extended into percutaneous nephrolithotomy.

The role of radiological intervention has also been well established in the management of vascular complication of PCNL; these urological emergencies have been dealt with reliably via minimally invasive radiological intervention.

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