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What is This?
Second-look nephroscopy after percutaneous nephrolithotomy

Bodo E. Knudsen

Abstract: Percutaneous nephrolithotomy (PCNL) is the standard of care for the management of large renal stone burdens. Residual stones after PCNL may be cleared with a second-look nephroscopy. Determining whether a patient should undergo a second-look procedure is based on both the intraoperative findings and the post-operative imaging. Aggressive intraoperative flexible nephroscopy, may reduce the need for routine second-look nephroscopy. Post-operative computed tomography (CT) imaging is the most sensitive method for detecting residual stone fragments. When a clinically significant residual stone burden exists a second-look procedure may be performed in an effort to render the patient stone-free. In most instances the procedure can be performed in an ambulatory facility under conscious intravenous sedation. Future prospective study determining the threshold of fragment size after PCNL that warrants second-look nephroscopy is needed.

Keywords: nephroscopy, nephrolithotomy, calculus

Introduction

Percutaneous nephrolithotomy (PCNL) is a highly effective surgical treatment for patients with large upper tract stone burdens. The safety and efficacy of the procedure is well documented and is a major improvement over open stone surgery. PCNL was first introduced in the 1980s and many enhancements to both the technique and the instrumentation have occurred further improving efficacy and reducing morbidity [Kim et al. 2003]. The advent of highly effective lithotrites, such as the combination pneumatic/ultrasonic devices (Swiss LithoClast Master, EMS, Nyon, S2) have reduced operating times and improved stone free rates [Preminger et al. 2000].

While PCNL is highly effective at treating large stone burdens, occasionally residual fragments are left and a secondary procedure warranted. Second-look nephroscopy is a surgical procedure where a patient who recently underwent a PCNL, undergoes a second procedure where the collecting system is entered percutaneously through the previously established tract in an attempt to render the patient stone-free. The procedure is usually performed prior to the patient’s discharge from hospital, although it can also be performed as an outpatient at a later date, provided the nephrostomy tube has not yet been removed. The procedure may be performed with the patient awake, under conscious intravenous (IV) sedation, or under spinal/general anesthesia. Some have advocated routine second-look nephroscopy in all patients undergoing PCNL with the rationale that 17% of patients have residual calculi after PCNL not detected on post-operative imaging [Denstedt et al. 1991]. Others have suggested performing a second-look nephroscopy only in select patients or not at all [Portis et al. 2008; Davol et al. 2006].

Flexible nephroscopy

The development of flexible nephrosopes was an important step in the evolution of PCNL. Flexible nephrosopes are identical to flexible cystoscopes and can be used interchangeably. Recently, there has been a shift from fiber optic endoscopes to digital instruments promising improved image quality and better ergonomics [Borin et al. 2006]. By using a flexible nephroscope, the surgeon is able to reach portions of the collecting system that might not have been reached with a rigid instrument. This allows for careful inspection of the renal collecting system...
and upper ureter at the time of PCNL with the goal to render the patient stone-free [Beaghler et al. 1999]. Ongoing bleeding or difficult intrarenal anatomy, such as an adjacent parallel calyx containing a stone, may limit the effectiveness of the technique. Flexible nephroscopes are also routinely used to perform second-look nephroscopy.

Nephrostomy tube placement after PCNL

Traditionally, nephrostomy tubes have been routinely left after PCNL with the threefold goal to tamponade bleeding; provide renal drainage; and allow for access for a second-look procedure [Kim et al. 2003]. In recent years, some surgeons have advocated ‘tubeless’ PCNL and have not routinely placed nephrostomy tubes after PCNL in an effort to decrease post-operative pain and analgesic use, reduce the length of hospital stay, and speed the return to regular activities [Gupta et al. 2005; Bellman et al. 1997]. The decision to not leave a nephrostomy after PCNL eliminates the ability of the surgeon to perform a second-look nephroscopy. In this manuscript the current role of second-look nephroscopy after PCNL will be reviewed followed by a discussion of the technical aspects of the procedure.

Second-look nephroscopy—when to intervene

Ideally second-look nephroscopy should be performed in patients with known residual stone fragments that are ‘clinically significant’. The crux of the challenge is accurately determining whether there are residual stone fragments after PCNL and then assessing if they are in fact clinically significant. Intraoperatively, direct visual inspection combined with fluoroscopy is used to determine if the entire stone burden has been cleared. Bleeding, retained contrast, and difficult anatomy may result in retained fragments. Post-procedure imaging is performed to determine if residual stone fragments are present. Non-contrast computed tomography (CT) has a sensitivity of 95% for detecting fragments less than 3 mm in size. Alternative imaging modalities have lower sensitivities and include plain radiography (60%), linear tomography (55%), and ultrasonography (15%) [Lehtoranta et al. 1999]. CT imaging has a false positive rate of 12.2% which may be due to Randall’s plaques or dust like stone debris that could not be retrieved at the time of surgery [Pearle et al. 1999].

A recent study presented at the American Urological Association Annual Meeting (AUA Orlando 2008) reported 42 patients who underwent PCNL and were found to have residual fragments by imaging. Of these 42 patients, 42.9% went on to develop a stone-related event (growth of fragment, emergency room visit, hospitalization, or additional intervention). When extrapolated by stone size, for fragments >2 mm, 71% developed a stone-related event versus only 24% with fragments <2 mm [Raman et al. 2008]. This suggests that 2 mm may be a reasonable cut-off in counseling a patient regarding whether to proceed with a second-look procedure.

‘Tubeless’ PCNL

The advent of ‘tubeless’ PCNL has resulted in some patients not having a nephrostomy tube left at the completion of a PCNL. Rather, a urinary stent is left or, in some situations, no drain at all [Karami and Gholamrezaie, 2004; Bellman et al. 1997]. Potential benefits include reduced hospital stay, decreased analgesic requirements, and more rapid return to daily activities. A major limitation is that second-look nephroscopy cannot be performed if residual stones are detected. Therefore the ability to determine if the patient is stone free at the time of the PCNL is of paramount importance. One study evaluated the use of aggressive flexible nephroscopy, where every individual calyx was inspected under direct vision twice, combined with high resolution fluoroscopic imaging at the time of PCNL. If the patient was deemed stone free at the time of PCNL, no nephrostomy tube was left. Follow up CT imaging was done at 30 days post-procedure. Nine of 33 patients (27%) had residual stone fragments detected. However using 2 mm as a threshold for clinical significance, only 4 of 33 (12%) had fragments ≥2 mm and 0% had fragments >4 mm [Portis et al. 2008]. If one defines a significant stone as ≥2 mm, then patients would have a 12% risk of having a significant residual fragment after PCNL that could lead to a stone-related event post-PCNL with this approach.

Similarly, another report demonstrated a 15% rate of residual calculi on post-operative imaging performed by either KUB (82%) or CT (18%) in patients who underwent PCNL. This stone free rate was likely underestimated due to the small percentage of patients undergoing CT.
No patient underwent a second-look procedure. By a mean follow up of 8 months, 32% of patients had evidence of residual or recurrent stones. Again, only 30% had imaging via CT suggesting that the true incidence of residual or recurrent stones was higher [Davol et al. 2006]. The high recurrence rate suggests that an opportunity to improve the stone-free rate via a second look procedure may have been missed.

Struvite stones may warrant more aggressive management post-PCNL. Struvite stones form from magnesium ammonium phosphate crystals (MgNH₄PO₄·6H₂O) that are admixed with carbonate apatite (Ca₁₀(PO₄)₆·CO₃) secondary to the high urinary pH created by urease producing bacteria. The bacteria are thought to be protected by the stone matrix and therefore less susceptible to antibiotic therapy. Residual fragments after PCNL can grow quickly and recurrent staghorn stones can develop. Therefore aggressive intervention of residual fragments in these patients appears justified.

**Technique: second-look nephroscopy**

Second-look nephroscopy can be performed in a number of different settings including an ambulatory outpatient setting (with or without conscious sedation) or in the operating room (under conscious sedation or spinal/general anesthesia). The decision where to perform the procedure should be individualized to the patient based on the size and location of residual calculi, the patient’s ability to tolerate an ambulatory procedure, and other comorbidities that the patient may have. Our approach is to perform the majority of second-look nephroscopies in the ambulatory outpatient facility under intravenous conscious sedation. Patients who have a large residual stone burden that would not be amenable to either basket extraction or minimal laser lithotripsy undergo second-look procedures in the operating room under general anesthesia.

When post-operative imaging demonstrates significant residual calculi after PCNL, the patient is assessed for second-look nephroscopy on post-operative day one. Hematuria can limit visibility and it is best to postpone the procedure until the hematuria is resolving. Patients with signs of bacteremia or sepsis (tachycardia, hypotension, decreased urine output or fever) are also not candidates for second-look procedures. For patients who are deemed fit for the procedure, an informed consent is obtained and they are transferred to our ambulatory surgical facility which is attached to our medical center. After completing a pre-procedure assessment, including a thorough evaluation of their airway, a blood pressure cuff and a pulse oximeter are applied. It is imperative that the patient have a Foley catheter in place prior to initiating the procedure, as the bladder can fill quickly with irrigation fluid during the second-look nephroscopy leading to discomfort. Patients are positioned prone on the procedure table and oxygen via nasal prongs is administered. Although not absolutely necessary, it is preferred to have a fluoroscopic C-arm available. Our table has in integrated motorized C-arm and is used during all second-look procedures. Conscious IV sedation is initiated with a combination of midazolam, fentanyl, and phenergan. Initially 12.5–25 mg of phenergan is administered to decrease nausea. A starting dose of midazolam 2 mg and fentanyl 100 μg is given. Frail or elderly patients should be started at one half of this dose. Patients with a history of chronic narcotic use will require higher doses of midazolam and fentanyl to become adequately sedated due to drug resistance. It is prudent to titrate midazolam and fentanyl in aliquots of 1 mg and 100 μg respectively until adequate sedation is achieved. The patient’s pulse, blood pressure, and oxygen saturation are continuously monitored by the nursing staff during the procedure and any problems communicated to the surgeon.

Once the patient is adequately sedated, the nephrostomy tube is cut about 3–4 cm from the level of the skin. We routinely leave a 10 Fr pig-tail style nephrostomy tube after PCNL. Despite the small caliber of the tube, dilation of the nephrostomy tract is not required at the time of the second-look procedure. The silk suture holding the tube in place is left intact at this time. The patient’s flank and remaining portion of the nephrostomy tube is prepped and then draped with our standard nephrostomy drape (Kimberly Clark, Dallas, TX). A scout image is obtained and saved to a second monitor. This is an important step as the residual stone may be difficult to visualize once contrast is injected. An antegrade nephrostogram is performed followed by the insertion of a 0.035” dual durometer guide wire (Sensor, Boston Scientific, Natick, MA). The wire is coiled in the collection system and the nephrostomy tube is removed. A 5 Fr 40 cm Bern torque catheter (Boston Scientific) is used to direct the wire down the ureter to the bladder.
It is then secured to the drape as a safety. We do not routinely place a sheath during second-look procedures in the ambulatory setting. A digital flexible nephroscope (CY-F2, Olympus Surgical, Tokyo, Japan) is passed along side the guide wire through the nephrostomy tract into the collecting system. Normal saline (0.9%) is used for irrigation. A pressurized irrigation system is not used as the flow through the nephroscopy is adequate with gravity alone. It is unusual that the collecting system cannot easily be entered, but in the event of difficulty, a second guidewire can be placed and the nephroscope can be advanced using the Seldinger technique.

Once the collecting system is entered, careful inspection is performed both under direct vision and with fluoroscopic guidance. For stones that can be removed without further lithotripsy, a tipless nitinol stone basket is used. For smaller stones, a 1.5 Fr basket is used (Halo, Sacred Heart Medical Inc., Minnetonka, MN); for larger stones a 3.0 Fr basket is selected (ZeroTip, Boston Scientific). If the stone is too large to extract, then a holmium:YAG laser is used to fragment it. A 365 μm core sized optical fiber is loaded through the flexible nephroscope and the stone fragmented using pulse energy of 0.8–1.0 J at a frequency of 8–10 Hz. The fragments are then removed with the nitinol basket. The collecting system is carefully inspected under direct vision and with fluoroscopic guidance to ensure all fragments have been cleared. The nephroscope is then removed and the nephrostomy tube is left out. If the second-look procedure could not be successfully completed, a nephrostomy tube or antegrade stent can be placed under fluoroscopic guidance. Patients are transferred to the recovery area where they are monitored for approximately 60 minutes. Once awake and alert, the Foley catheter is removed. Most patients are discharged home later the same day.

Patients with supracostal tracts can safely undergo a second-look nephroscopy provided that post-operative imaging has ruled out thoracic complications such as a pneumo- or hemothorax. Additional analgesic may be required during the procedure due to the proximity of the intercostal nerve.

**Conclusion**

Second-look nephroscopy remains an important tool in the armamentarium for treating renal calculi.

The practices of aggressive flexible nephroscopy coupled with high resolution intraoperative fluoroscopy may reduce the need for second-look procedures. Furthermore, patients determined to be stone-free by CT imaging after PCNL should not require a second-look procedure. However, for patients with significant residual fragments post-PCNL, a second-look procedure has the potential to render them stone-free and reduce future stone related events. Second-look nephroscopy can be performed safely in an ambulatory facility under IV conscious sedation. Future prospective study should be aimed at determining the threshold of fragment size after PCNL that warrants second-look nephroscopy in order to reduce future stone-related events.

**Conflict of interest statement**

Consultant, Boston Scientific.

**References**


