

# Management of the staghorn calculus: multiple-tract versus single-tract percutaneous nephrolithotomy

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## Purpose of review

Complete removal of stones is crucial for preventing recurrence and morbidity. Currently percutaneous nephrolithotomy is the preferred treatment modality. The debate continues over the use of single tract versus multiple tract percutaneous nephrolithotomy. We review papers on the topic published over the past 12–24 months.

## Recent findings

Articles related to single and multiple tracts were reviewed. We discuss the morbidities, advantages and disadvantages of both the approaches. To decrease the number of tracts few authors have shown the efficacy of flexible ureteroscopy and nephroscopy as an adjuvant procedure. The authors state that this option effectively decreases the disadvantages of multiple tracts, namely blood loss complications, without compromising on stone free rates.

## Summary

Several techniques have been described for percutaneous access and stone removal, all of them associated with inherent problems. Although feasible, access to all the calices will be difficult through one percutaneous tract because of the peculiarities of the renal collecting system, in which case, multiple-access percutaneous nephrolithotomy is the mainstay of the treatment. The crucial point to understand is that all cases should be dealt with on an individual basis.

## Keywords

flexible nephroscopy, multiple tract PCNL, single tract PCNL

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## Introduction

Staghorn calculi are branched, usually infected, stones that occupy a large portion of the collecting system, typically filling the renal pelvis and branching into several or all of the calices. An untreated staghorn calculus is likely to destroy the kidney and cause life-threatening sepsis. Complete removal of the stone therefore is crucial in order to eradicate any causative organisms, relieve obstruction, and prevent further stone growth. Percutaneous nephrolithotomy (PCNL) is currently the preferred first-line treatment for staghorn and other large renal calculi.

The debate continues over the use of single-tract versus multiple-tract PCNL in these cases. With either method, the primary objectives are complete clearance of the stone with minimal morbidity. In this paper, we review and summarize the literature from the past 12–24 months in order to define the advantages and disadvantages of both treatment options.

## Multiple tracts for percutaneous nephrolithotomy

The American Urological Association Guidelines Panel has suggested that two or more access sites may be required to clear a large stone [1]. Manohar and colleagues [2<sup>••</sup>], in their series of 35 children, described the technique of ‘multi miniperc’. The average bulk of the stones was  $140.17 \pm 42.16 \text{ mm}^3$ . The stone-free rate was 86%, the mean haemoglobin drop was  $2.2 \pm 0.95 \text{ g/dl}$ , and the mean hospital stay was 3.5 days. Fewer than half of the patients (42%) were treated in a single stage, the remainder requiring multiple procedures. Only 39% of the patients could be rendered stone free with a single tract. There was statistically significantly greater blood loss in patients requiring multiple tracts ( $P = 0.008$ ); however, staging the procedure did not increase the blood loss ( $P = 0.06$ ). The authors concluded that multitract PCNL is safe and effective in children younger than 5 years. Staging the procedure, instrument modification, the timed multi miniperc technique, and ultrasound-guided access

helped in achieving maximum stone clearance with minimal morbidity. This paper stresses the importance of the fact that even in children as young as 11 months, complete clearance of stones can be achieved with staged, multiple small-tract PCNL. Although increasing the number of tracts exponentially increases the blood loss, it does not add to the overall complication rate [2\*\*].

Liatsikos and collaborators [3] describe a technique of a single subcostal skin incision with multiple angular punctures to approach the superior, middle, and lower portions of the kidney. One hundred patients were studied. The superior calix was approached by a subcostal triangulation technique and the middle and lower calices by angular punctures. Eighty-seven percent of patients were stone free after a single session, with one case of excessive haemorrhage necessitating embolization. This study highlighted the experience that multiple punctures are required for stone clearance in one sitting. The technique decreases the number of skin incisions needed to achieve clearance [3].

Auge *et al.* [4] in their series did not find any difference in the complication rates when a single tract was used compared to multiple tracts; they noted, however, a higher transfusion rate when multiple tracts were employed. They conclude that multiple tract PCNL can be done with a single anaesthetic with similar morbidity as single tract PCNL [4].

Hegarty and Desai [5] prospectively compared the outcome of PCNL with a single tract versus multiple tracts ( $n=20$  in each group). All single-tract and 95% of the multiple-tract patients were rendered stone free. The mean drop in haemoglobin was similar in the two groups. Four multiple-tract patients required blood transfusion. The need for transfusion correlated with lower preoperative haemoglobin and higher preoperative serum creatinine concentrations. There was a significant rise in serum creatinine and a drop in creatinine clearance in the multiple-tract group; this was more in patients with renal insufficiency. These authors stress the fact that monotherapy with PCNL utilizing multiple percutaneous tracts is highly effective in the treatment of staghorn and other large-volume renal calculi. Blood loss and complication rates are similar to those of PCNL with single tracts for more straightforward calculi [5]. Although the study demonstrated the efficacy of as many as six tracts, it has two inherent limitations, namely small sample size and difference in baseline demography data.

Aron and associates [6] presented data to support multi-tract PCNL for large complete staghorn calculi. One hundred and twenty-one renal units were treated. Fluoroscopy-guided punctures were made by the urologist

followed by tract dilation to 34°F. When multiple tracts were anticipated, all punctures usually were made at the beginning, and guidewires were put into the collecting system or down the ureter. The number of tracts was two in 11 patients, three in 68, four in 39, and five in three. The points of entry were an upper calix in 121 cases (30.4%), a middle calix in 178 (44.8%), and a lower calix in 98 (24.6%). Complications were septic shock in one, hydrothorax in three, and pseudoaneurysm in two. Monotherapy with PCNL achieved an 84% complete clearance rate. The authors concluded that aggressive PCNL monotherapy using multiple tracts is safe and effective and should be the first option for massive renal staghorn calculi [6].

Davol and collaborators [7] presented data on 43 consecutive patients in whom second-look procedures were not performed. Patients were considered stone free if no calculi were evident by either plain film or noncontrast computed tomography scan. Of these patients, 15% had immediate postoperative evidence of residual fragments. At a mean follow-up of 8 months, 32.5% had residual or recurrent stone. There were statistically significant correlations between both patient age and stone size and the risk of recurrent or residual stone. Thus, PCNL was effective for the single-stage treatment of large renal calculi. Aggressive stone clearance obviated routine second-look nephroscopy. The excellent stone-free rate achieved suggests that such nephroscopy may not be necessary for the majority of patients undergoing PCNL [7].

Rodrigues Netto *et al.* [8] compared the success and complication rates of staghorn calculi treated through an upper or middle calix and those in whom multiple accesses were utilized. A single access was created in 72.3% of the patients, whereas multiple accesses were performed in 27.7%. The stone-free rate was 80.0% with lower and middle-caliceal punctures, 87.5% with upper-caliceal puncture, and 84.8% with multiple access tracts. Bleeding necessitating transfusion was significantly more common in the multiple-access group. The authors concluded that stone clearance is highly related to the appropriateness of the access and that the supracostal and multiple access approaches can be used with a slight increase in the incidence of complications [8].

#### **Single-tract percutaneous nephrolithotomy with flexible nephroscopy, ureteroscopy, or both**

The concept of PCNL and the use of flexible nephroscopy was initially published by Wong and Leveillee in 1992.

Wong and Leveillee [9] in their series described a stone free rate of 95% in patients treated with single percutaneous tract with flexible nephroscopy. Use of flexible nephroscopy with holmium:YAG laser lithotripsy and

nitinol basket stone extraction rendered renal units stone free in a mean of 1.6 procedures. The holmium: YAG laser was a safe lithotrite for the kidney, as no complications occurred from its use [9].

Recently a few papers have been published which demonstrate the use of flexible instruments for gaining access and decreasing the number of tracts.

Undre *et al.* [10] assessed the use of flexible instruments through percutaneous and retrograde approaches. They present a case of 'pass the ball', helpful in tackling large, complex, or branched staghorn calculi without the need for multiple percutaneous punctures, removing larger fragments. This avoids multiple passes through the ureter, saving time and decreasing the possibility of iatrogenic ureteral injury. The authors' hypothesis is that the technique combines the advantages of PCNL and flexible ureteroscopy effectively decreasing the number of tracts required in complex stones. They conclude that this effectively reduces the potential morbidity and discomfort associated with multiple tracts without compromising on stone free rates.

Grasso *et al.* [11] describe a combination of retrograde flexible ureteroscopic techniques with simultaneous percutaneous access to gain precise antegrade access. They have utilized this technique in cases with minimally dilated systems and complex stone burdens. They conclude that simultaneous flexible ureteroscopy helps in gaining access into the precise calix.

Lonjanawipat and Prasopsuk [12] compared the efficacy and safety of the supracostal and infracostal upper-pole approaches. PCNL with upper pole access was effective using both supracostal and infracostal approaches, with acceptable rates of complications. The rate of pulmonary complications was higher with the supracostal approach. If the supracostal approach is indicated, it should be used with caution. This paper assumes importance in cases for which a single-tract approach with the use of flexible nephroscopy is contemplated. The supracostal approach definitely should be used with caution [12].

Marguet and coworkers [13] presented early experience in managing complex renal calculi using a combined ureteroscopic and percutaneous approach with a single tract. The study included seven patients with multiple branched, large-volume calculi suitable for management with PCNL. All patients had either two or more stones in separate locations in the collecting system or staghorn stones involving multiple calices. Stone-free rates were determined by follow-up imaging at 3 months. Two patients had small (<3 mm) residual stones

that necessitated ureteroscopic intervention, as the fragments failed to pass spontaneously by 3 months after the initial combined procedure. The authors concluded that combined PCNL and ureteroscopic management can reduce the number of percutaneous access tracts that would otherwise be required for managing complex and branched renal calculi. This procedure reduces patient morbidity and blood loss. It does not affect the stone free rate. Although these authors stress the importance of reducing the number of tracts, the study is not adequately powered (only seven patients). In addition, three patients required intervention as the stone failed to clear after 3 months [13].

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## Conclusion

The aim of treating staghorn stones is to achieve complete clearance of the stone burden with minimal morbidity, namely, fewer complications, shorter hospital stay, and lower transfusion requirements.

As the numbers of tracts increase, the blood loss increases exponentially. In our experience, however, blood loss can be reduced by taking measures such as ultrasound-guided punctures, staging the procedures, and limiting the nephroscopy time at a given session to 90 min. The multiple-tract approach has the ability to achieve stone clearance without increasing the cost of instruments. A surgeon who can achieve a primary tract can very well create secondary tracts. This does not require a learning curve to be overcome. The clearance rate in the multi-tract approach is not dependent on the anatomy such as infundibular stenosis.

The use of single-tract PCNL with ancillary procedures such as flexible ureteroscopy and flexible nephroscopy requires a supracostal approach in many cases, which carries a higher complication rate. The ancillary procedures performed are part of the procedure. This might hamper the vision as a result of subsequent oozing.

In addition to the cost involved in the instrumentation, flexible instrument use requires a learning curve to be overcome.

In conclusion, several techniques have been described for percutaneous access and stone removal, all of them associated with inherent problems. Although feasible, access to all the calices will be difficult through one percutaneous tract because of the peculiarities of the renal collecting system, in which case, multiple-access PCNL is the mainstay of the treatment. The crucial point to understand is that all cases should be dealt with on an individual basis.

## References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 258).

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