Efficacy and Safety of PCNL in Solitary Functioning Kidneys with Complex Renal Calculi

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ABSTRACT

Purpose: The study was carried out to analyse the safety and efficacy of PCNL in solitary functioning kidneys.

Material and Methods: A total of 40 patients with complex renal calculi in solitary functioning kidneys were included in this study. Eighteen patients (45%) had renal insufficiency on presentation. Ten patients required haemodialysis to correct uraemic symptoms. Eighteen patients required placement of percutaneous nephrostomies for relief of urinary obstruction prior to the definitive procedure. Procedure was completed in one stage in 31 patients. It was completed as a planned staged procedure in 9 patients of whom 7 patients required two stages and 2 required three stages. Complete clearance could be achieved through one tract in 30 patients (75%). 9 patients required two tracts while only one required three tracts.

Results: Complete clearance was achieved in 30 patients (90%). Three patients required ESWL for clearance of residue, one was lost to follow-up. Significant bleeding was seen in 3 patients (7.5%). Renal function did not deteriorate in any patients.

Conclusion: PCNL in solitary kidneys can be safe even for complex calculi if the procedure is planned properly and completed in stages whenever required.

INTRODUCTION

The management of calculi in a solitary kidney is a difficult problem, more so if the stone burden is large or if there are multiple calculi in the pelvicalyceal system.

There is no uniformity of opinion as to how to manage these calculi. The problem is complicated by impaired renal function and infection in many of these patients.

Opinions regarding management of staghorn calculi have varied in the past, from advocating conservative treatment to the other extreme of aggressive surgery. However, it is realized that staghorn calculi will eventually destroy the kidney and result in up to a 30% mortality rate. Antrhopathic nephrolithotomy and hypothermia were the open surgical procedures of choice for removal of staghorn renal calculi particularly in difficult cases. This trend continued till the advent of percutaneous nephrolithotomy. The American Urological Association Nephrolithiasis Clinical Guidelines Panel mentions open surgery, percutaneous nephrolithotomy and combination of PCNL and ESWL as reasonable alternatives for management of staghorn calculi.

If the advantages of an endoscopic approach can be extended to complex calculi in solitary kidneys, the morbidity, hospital stay and cost of treatment can be significantly reduced. However, in solitary kidneys the treatment should be achieved with the aim of complete clearance of the calculus without any further deterioration in renal function. This study was carried out with the aim of assessing the safety and the efficacy of this procedure with respect to the above two end points.

PATIENTS AND METHODS

40 patients with complex calculi in solitary functioning kidneys who underwent percutaneous treatment at this hospital from January 1991 to July 1996 were included in this study.

Patients were classified as having a solitary functioning kidney if the other kidney was either non-functioning on
intravenous urography, was surgically removed previously or was congenitally absent. The calculi were classified using the criteria of Griffith and Valiquette as complex when they involved more than one cavity of the urinary collecting system.6 The cavities could either be a calyx, infundibulum, pelvis or the upper ureter. These could be multiple calculi occupying more than one cavity or a single calculus with extension into other cavities. All patients had a large stone burden. The distribution of calculi is shown in Table 1.

The study included 33 males and 7 females ranging from 5 to 68 years in age. The mean age was 40.6 years. Eight patients had undergone a previous operative procedure on the same side.

Eighteen patients (45%) had renal insufficiency at presentation (defined as Serum Creatinine > 1.5 mg/dl). Clinical features of uraemia necessitated haemodialysis in ten patients. A percutaneous nephrostomy for relief of urinary obstruction was done in these 18 patients as a separate procedure 3 to 5 days prior to the definitive procedure. These nephrostomies were placed keeping in mind the subsequent definitive procedure and the same tracts after dilatation were used for removal of the calculi at a later date. 17 patients had urinary tract infections with positive urine cultures on presentation. They were put on appropriate antibiotic therapy and were posted for surgery only after a repeat culture showed sterile urine. Preparation for the definitive procedure included the careful study of the plain film with the IVU or nephrostogram plate. Additional oblique plates were taken to assess the best approach and feasibility of clearance of the calculi from the various calyces.

Standard PCNL technique was followed. Under general anaesthesia, the initial puncture was made under ultrasound guidance through the preselected calyx and anticipated multiple punctures were made in the beginning. In patients with previously placed nephrostomies the same tracts were used. Appropriate-sized Amplatz sheath was used in all cases. The operation was done as a planned staged procedure in 9 patients of which 7 patients required two stages and 2 patients required three stages. The time interval between each stage was 3 days. Each stage was limited to a total anaesthesia time of one hour. In ten patients with upper ureteric calculi the calculus was pushed into the pelvis from the ureter and removed through the percutaneous tract. Few of the calyceal calculi required separate needle punctures and saline wash to push them into the pelvis or the main percutaneous tract, from which they were subsequently picked up. The number of tracts required for clearance are shown in Table 2.

Complete clearance of the calculus was achieved through one tract in 30 patients (75%). Nine patients required two tracts while only one patient required three tracts. Considering the solitary kidney status of these patients a DJ stent was passed antegradely in all the cases. The operative time, considering all stages varied from a minimum 40 minutes to a maximum of 180 minutes. The average operative time was 69 minutes. The mean hospital stay was 8.2 days. The follow-up ranges from 6 months to 5 years with a mean follow-up of 2.6 years.

RESULTS

Complete clearance, defined as absence of any residual fragments on plain X-ray (Figs. 1 & 2) and USG of the kidneys at the end of 3 months was achieved in 36 patients (90%). Four patients had significant residual calculi defined as fragments > 4 mm. Most of the residue was present in the lower calyx. Of these, three patients achieved complete clearance after ESWL while one was lost to follow-up. The various complications encountered in this series are shown in Table 3. Perforations occurred in two patients. It was seen on the medial wall of the renal pelvis in one patient and at the calyceal infundibulum in one patient. The procedure was terminated and had to be completed in a second stage in both the cases due to poor visibility.

Significant bleeding was encountered in 3 patients and they required blood transfusions. It required termination of the procedure due to poor visibility in one patient. Clearance was achieved in the second stage and no significant bleeding was encountered then. Two more patients had a drop of haemoglobin > 3 gm% and required

<table>
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<tr>
<th>TABLE 1</th>
<th>DISTRIBUTION OF CALCULI</th>
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<tr>
<td>Type of Calculi</td>
<td>Distribution of Calculi</td>
</tr>
<tr>
<td>Staghorn Calculi</td>
<td>5 (12.5%)</td>
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<tr>
<td>Partial Staghorn</td>
<td>7 (17.5%)</td>
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<tr>
<td>Multiple Calyceal Calculi</td>
<td>18 (45.0%)</td>
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<tr>
<td>Renal + Ureteric Calculi</td>
<td>10 (25.0%)</td>
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<tr>
<th>TABLE 2</th>
<th>PCNL TRACTS REQUIRED FOR CLEARANCE</th>
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<tbody>
<tr>
<td>No. of Tracts</td>
<td>No. of Patients</td>
</tr>
<tr>
<td>1</td>
<td>30 (75.0%)</td>
</tr>
<tr>
<td>2</td>
<td>9 (27.5%)</td>
</tr>
<tr>
<td>3</td>
<td>1 (2.5%)</td>
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perioperative blood transfusions. One of them had undergone a pyelolithotomy previously and extensive perirenal fibrosis made dilatation of the tract difficult and hindered manoeuvrability of the nephroscope. The other patient had required three tracts for removal of a large staghorn calculus.

Postoperative pyrexia was the commonest complication noted in ten patients. All febrile episodes occurred during the first 48 hours but responded to oral antipyretics. Urosepsis (positive urine culture, fever and an elevated leucocyte count) occurred in six patients (15%). E. Coli and Proteus were the commonest organisms cultured. These patients responded to antibiotics administered according to the culture report.

Fluid absorption syndrome or hyponatraemia was not seen in any patient. Minimal urinary leakage after nephrostomy tube removal was seen in 3 patients. All had DJ stents in situ and the leakage was attributed to urinary reflux from the stents. The leakage necessitated reinsertion of urethral catheter for 3 days after which the leakage stopped completely.

The renal function did not deteriorate in any patient. Postoperatively one patient required two sessions of haemodialysis for hyperkalemia and oliguria. He had impairment of renal function on presentation.

Patients were followed up at 1 month, 3 months and at 6 monthly intervals. Sr. creatinine, urine culture and USG was done at every follow-up visit.

Three months following surgery, of the 18 patients who had presented with impaired renal function the serum creatinine became normal in 8 patients while it was stable

<table>
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<tr>
<th>Complications</th>
<th>No. of Patients</th>
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<tr>
<td>Bleeding</td>
<td>3 (7.5%)</td>
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<tr>
<td>Infection</td>
<td>2 (5.0%)</td>
</tr>
<tr>
<td>Fever</td>
<td>10 (25.0%)</td>
</tr>
<tr>
<td>Urosepsis</td>
<td>6 (15.0%)</td>
</tr>
<tr>
<td>Urinary Leakage</td>
<td>3 (7.5%)</td>
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Figure 1: Preoperative KUB showing left staghorn stone.

Figure 2: Postoperative KUB showing complete clearance.
but high in 9 patients and one patient progressed to end stage renal disease (serum creatinine 1.5 to 5.5 mg/dl). The serum creatinine levels preoperative and postoperative of 18 patients who had presented with impaired renal function are shown in Fig. 3. Urine culture was positive in only two patients. These were the patients with residual calculi and were treated with antibiotics prior to ESWL.

Intravenous urography was done at 6 months follow-up visit in 20 patients. There was prompt concentration and excretion of contrast and no residual calculus in any of the patients. Five patients had minimal residual dilatation of the pelvicalyceal system.

DISCUSSION
The aim of treating staghorn and complex renal calculi has always been to achieve a complete removal of the
entire stone safely and expeditiously so as to achieve the highest stone clearance with the lowest possible complication and secondary procedure rate. When such calculi are present in solitary functioning renal units, these aims are to be achieved saving nephrons and renal function. The chosen treatment modality should be as safe as well as effective. Currently four reasonable treatment alternatives have evolved. These are open surgery, percutaneous nephrostolithotomy, ESWL and combination of percutaneous nephrostolithotomy and ESWL. Open surgery was the primary treatment modality for treatment of complex calculi for a very long time.4,5,6 The various surgical procedures included extended pyelolithotomy, anatomic nephrolithotomy or multiple radial nephrotomies for removal of all calculi. However complete removal of staghorn and complex calculi by open surgery is often a difficult task and the incidence of residual fragments varies from 0 to 26% with an average of 17%.7,8,9,10 The AUA Nephrolithiasis Clinical Guidelines Panel in their meta-analysis of treatment modalities for staghorn calculi has found a 81.6% stone-free rate for open surgery but 11.9% incidence of acute significant complications.5 Surgical management may also cause vascular damage to the kidney and a decrease in renal function.3 This would be undesirable in patients with solitary functioning renal units. 8 patients of our series had undergone operative procedures for calculi on the same side. Reoperation on the same side often becomes difficult and hazardous.

The initial report of percutaneous approach to staghorn calculi came in 1983 and the procedure was advocated for patients who had undergone previous surgery for calculus or who were poor surgical risks.11 The scope of percutaneous nephrostolithotomy has expanded tremendously in the last few years and—has become the modality of choice for nearly all cases with a large stone burden.7

The limiting factor for the treatment of complex calculi in solitary kidneys by percutaneous approach has been the length of time available under anaesthesia for completion of the procedure.7,11 However with increasing experience and developments in nephroscopy and equipment for intra-corporeal lithotripsy equipment, the percutaneous approach has become more appealing.7 The only problem with PCNL is residual fragments or presence of calculi in unapproachable calyces.1 In the AUA Nephrolithiasis Panel analysis, the residual fragment rate after PCNL was 26.7% with significant complication rate of 7.4%.3 ESWL is also far from ideal as in the same analysis ESWL mono-therapy had the lowest stone free rate of 50% and the highest complication rate of 30.8%.3 Meretyk et al in their study found a stone-free rate of only 22% in patients undergoing ESWL monotherapy for staghorn calculi.12 To further enhance the clearance rates and to reduce complications, PCNL and ESWL were used in combina-

tion. In the AUA report, the stone-free rate of combination therapy is 80.8% but significant complications occurred in 24.4% patients.3 This group however had the longest hospital stay. Meretyk et al in the first prospective, randomized single center study comparing ESWL monotherapy with combination therapy found a significantly better stone free rate at 6 months in patients undergoing combination therapy (74% vs 22%).12 There were a higher number of septic complications in the ESWL monotherapy group (15% vs 2%). They recommended PCNL plus ESWL as the first line treatment choice for most patients with staghorn calculi.14 However this study did not have any solitary functioning renal units. Moreover PCNL was done mainly as a debulking procedure through one tract. The residual calculi were treated with a preplanned ESWL. Schulz et al reported a residual stone rate of approximately 23% when PCNL and ESWL were combined.11 The AUA panel recommends that neither ESWL or open surgery should be a first line treatment choice but combination of ESWL and PCNL should be used.4 Hence percutaneous stone removal techniques are still needed as the primary treatment modality in patients with complex stones.

The residual fragment rate after aggressive PCNL monotherapy for staghorn calculi as advocated by Snyder and Smith at 13.3% is even less than the combined modality approach, the advantage of percutaneous technique being better patient tolerance, decreased morbidity and cost effectiveness.7 However this modality is to be used cautiously in patients with solitary kidneys. Segura et al advocate a proper preoperative planning of the procedure and the likelihood of repeat procedure and multiple sessions in treating complex calculi. They have also used PCNL in solitary kidneys in 15 patients but not for complex calculi. They found no unusual difficulties and postoperative studies of renal function were similar as in other situations.16 Considering the solitary kidney status of these patients multiple tracts cannot be made for fear of reducing renal function. It has been shown that a single tract has no effect on renal function while multiple tracts may damage nephrons and decrease renal reserve. Segura recommends open surgery for staghorn calculi if more than three tracts are required for clearance with or without ESWL.1 Stone clearance was achieved through a single tract in 75% of our patients and only one patient required three tracts. Renal function in our series also did not deteriorate in any patient.

We had no hesitation in completing the procedure in second stage, the emphasis being on reducing the anaesthesia time in a single sitting. Snyder and Smith reported an average total operating time of 155 minutes and the requirement of blood transfusion in more than 50% of their patients while treating staghorn calculi.
However, they were not dealing with solitary kidneys and could afford to use PCNL more aggressively. Our average total operative time was 69 minutes and transfusions were required in 7.5% patients. We believe that a staged procedure limits blood loss and chances of fluid absorption. Pre-placed nephrostomy tracts helped in making the second stage relatively easy and bloodless.

We had a complete clearance rate of 90% with PCNL and only 10% patients with residual calculi required ESWL. Solitary kidney with staghorn calculi should be made stone free expeditiously within safety limits. Rather than planning combined approach at the start, our endeavour has been to conscientiously clear all the calculi by PCNL and reserve ESWL only for the residue. We feel that this goes a long way in reducing septic complications and ancillary procedure which are so often required in the combined modality approach. The treatment of residual fragments of staghorn calculi by ESWL after percutaneous nephrolithotomy is similar to the shock wave treatment of simple stones. Due to the availability of ESWL residual and recurrent stones may be treated repeatedly with little risk.

**CONCLUSION**

In treating complex stones in solitary kidneys, it is desirable to achieve complete clearance to prevent regrowth and persistence of infection. PCNL in solitary kidneys can be safe even for complex calculi if the procedure is planned properly and completed in stages whenever required.

**Key Words:** Solitary Kidney; Percutaneous Nephrostolithotomy; Renal Calculi.

**REFERENCES**


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