Single lower calyceal percutaneous tract combined with flexible nephroscopy: A valuable treatment paradigm for staghorn stones

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Abstract

Introduction: We evaluated the efficacy and safety of single lower calyceal tract combined with flexible nephroscopy for the management of staghorn renal stones by percutaneous nephrolithotomy.
Methods: The medical records of patients who underwent percutaneous nephrolithotomy for the management of staghorn stones were analyzed. We included patients aged >18 years, while patients with incomplete data and renal anatomical anomalies were excluded from the study. Stone-free rate, postoperative complications, procedure duration, fluoroscopy time, and length of hospitalization were recorded. Postoperative outcomes were evaluated by non-contrast computed tomography scan 4–6 weeks after the operation. Stone-free status was defined as the absence of residual stones >4 mm.
Results: The study cohort consisted of 103 consecutive patients. Stone-free rate was 65.0%. No complications were observed in 69.9% of the cases; most postoperative complications were Grade 1 (13.6%) and 2 (10.7%). Five patients (4.9%) suffered a Grade 3a complication and another patient (1.0%) suffered a Grade 3b complication.
Conclusions: Percutaneous nephrolithotomy through a single lower calyceal tract combined with flexible nephroscopy can be a valuable treatment option for the treatment of staghorn calculi, providing efficacy and safety. Nevertheless, the present study is limited by both its retrospective nature and being conducted at a single centre and, thus, proper prospective studies with head-on comparisons are needed to prove or disprove the advantages and disadvantages of either approach.

Introduction

Percutaneous nephrolithotomy (PCNL) is currently the preferred first-line treatment for large and complex renal stones. Optimizing PCNL technique for treating this type of stones is a research field of great interest and clinical importance as stone-free rate (SFR) is lower and complications more frequent in patients with staghorn stones.[1] The efficacy and safety of PCNL is highly related to accurate placement of a percutaneous tract that provides direct access to the stone (optimal renal access). A single upper-pole access or multiple accesses are currently preferred providing straight and effective access to staghorn calculi and leading to higher SFRs than the lower calyceal approaches.[2] Nevertheless, lower calyceal access and single-tract accesses are associated with a lower complication rate and shorter hospital stay.[3,4] Thus, combining the safety of a single lower calyceal tract with high SFRs would be an optimal scenario. The aim of the present study is to evaluate the effectiveness and safety of single lower calyceal tract combined with flexible nephroscopy for the management of staghorn renal stones by PCNL.

Methods

After an approval by our institutional review board, we conducted a retrospective analysis of a prospectively collected database including the medical records of patients diagnosed with staghorn stones who underwent PCNL in our department within the period of June 2007 and March 2016. All procedures have been performed by a single experienced, fellowship-trained surgeon. We included all patients aged older than 18 years.

Based on the concept of the study, patients with staghorn stones were extracted from the primary database in order to be separately analyzed. We used the Picture Archiving and Communication System (PACS) of our hospital network for the extraction of all needed information. A preoperative non contrast computed tomography (NCCT) scan was conducted in all patients in order to evaluate stone characteristics (burden, side, location, density). Stone burden was calculated in mm^2, using the ellipsoid formula[5]: length*width*π*0.25, where π=3.14 and stone density was measured in Hounsfield units.

Under general anesthesia and with the patient in the prone position, an open-ended 5F/70cm ureteral catheter was inserted in the ipsilateral ureter with the use of flexible cystoscope. Through the latter, a retrograde pyelography was performed. The optimal posterior calyx for accessing the renal collecting system was identified fluoroscopically. Bull's-eye technique was used for puncturing the kidney in all patients. The puncture was always focused on the calyceal papilla and never to the infundibulum in order to avoid any arterial trauma and bleeding. A 0.035 angled guide wire was inserted into the ureter and it was exchanged with an extra-stiff wire. A 20atm balloon dilator was used for establishing a 30F tract. Lithotripsy was performed by ultrasonic lithotripter. Following stone fragmentation with ultrasonic lithotripter, flexible cystoscope was utilized for the identification and inspection of calculi that were un-identifiable with rigid nephroscope. It is the surgeon's standard

practice to treat staghorn stone with the combination of rigid and flexible nephroscopy instead of multiple accesses alternative. Stone fragmentation was obtained with 220μm Ho:YAG laser fiber. Stone extraction and removal was completed with 2.2F tipless stone basket. Flexible nephroscope was used for inspection of uretero-pelvic junction and proximal ureter. Furthermore, the rest of the ureter was evaluated for residual fragments by injecting contrast material through the flexible cystoscope and performing an antegrade ureterogram. Finally, a standard step in our technique at the end of the operation is the retraction of the access sheath until the level of the renal parenchyma to inspect carefully the area around the sheath for any residual stones. An 18F Council catheter was inserted at the end of the procedure for kidney drainage. Council catheter was removed the 2nd postoperative day after the performance of nephrostomogram.

Length of hospitalization, procedure duration, fluoroscopy time and postoperative complications were recorded. Operative and fluoroscopy time were calculated from the cystoscopy onset for ureteral catheter insertion until the placement of Council catheter. Duration of hospitalization was calculated from the day before the procedure until the date of discharge. Postoperative complications were graded according to Clavien-Dindo system.[6] Postoperative outcomes were evaluated by NCCT 4-6 weeks after the operation. Stone-free status was defined as the absence of any residual stone >4mm.

Statistical analysis was performed by SPSS software version 17 (SPSS Inc, Chicago, USA). Numerical variables are presented as mean ± standard deviation (sd). Categorical variables are described by their absolute number and percent frequency. Univariate analysis was used to analyze the association between stone-free status and several parameters. Mann-Whitney U test was used to compare means between numerical groups and Chi-square $\chi 2$ test for categorical variables. All p values were two-tailed and statistical significance was set at 0.05.

Results

Study cohort consisted by 103 consecutive patients who underwent PCNL for the management of staghorn stones. Patients demographics, clinical variables and stone characteristics are described in table 1. Seventy-two patients had a partial staghorn calculi (69.9%) compared to complete staghorn (30.1%). Stone-free rate at 1 month after the procedure was 65.0%, as found in postoperative NCCT. Residual stones location was mostly (>80%) the lower calyces. This does not mean that this was their primary location but mostly that residual stones were collected in lower calyces after the procedure. Postoperative stone-free status was significantly associated with stone burden ($p<0.001$) and the number of implicated calyces ($p<0.001$). Most of the patients had an uneventful postoperative course. No complications were observed in 69,9% of the cases while most of postoperative complications were of grade 1 (13.6%) and 2 (10.7%). Fourteen patients suffered a grade 1 complication (six patients had transient fever >38°C needed conservative management without antibiotics , four patients had postoperative pain managed with opioid analgesic, four

patients had bleeding managed by iv fluids not requiring blood transfusion). Eleven patients suffered a grade 2 complication (one patient had bleeding requiring blood transfusion, seven patients had fever >38°C treated with antibiotics, three patients had oxygen desaturation managed by administration of nasal O_2). Five patients (4.9%) suffered a grade 3a complication (urine leakage managed by placement of ureteral stent) and another patient (1.0%) suffered a grade 3b complication (angioembolism). Intraoperative findings and postoperative outcomes are seen in table 2.

Discussion

Staghorn calculi are branched stones that occupy a large portion of the collecting system. Management in these cases is, therefore, challenging and the aim should be the complete clearance of the stone burden with minimal morbidity, preservation of renal function and prevention of future recurrences. American Urological Association Guidelines Panel recommends PCNL as first-line treatment for the management of staghorn stones based on superior outcomes and acceptable low morbidity. According to their report, this approach is associated with a stone clearance rate of 74–83%, an acute complication rate of 15%, and an ancillary procedure rate of 18% and is clearly superior to extracorporeal lithotripsy monotherapy, combination therapy, and open surgery.[7] However, the ideal PCNL technique for staghorn calculi concerning the optimal renal access remains controversial.

Regarding the number of needed tracts currently the multiple-access PCNL seems to gain supporters. Although feasible, access to all the calices through a single percutaneous tract is difficult because of the peculiarities of the renal collecting system, therefore, multiple-access PCNL is the mainstay of the treatment conducted by many urologists, for the management of staghorn calculi.[8,9] Multi-tract approach preserve the advantage of offering straight and alternative accesses to the stone with use of large ultrasonic lithotripters for effective fragmentation and high SFRs . Accesses which are not prevented by the potential existence of anatomic anomalies such as malrotated kidney and infundibular stenosis, while the presence of which could make the access through a single percutaneous tract challenging. In addition, a surgeon who can achieve a primary tract can very well create multiple tracts and this does not require a learning curve to be overcome. Nevertheless, multiple tracts have the serious drawback of greater intra- and postoperative bleeding that necessitates transfusion, a complication which already has an increased rate in patients with staghorn stones.[1,10,11] Moreover, other complications including urosepsis, pelvicaliceal system perforation or persistent urine leakage are reported to be higher in the multi-tract approach.[12,13]

Selecting the ideal calyx to obtain access to kidney is a topic of great interest. The upper pole of the kidney is aligned medially and posterior to the lower pole, making the upper pole tract a shorter and easier access route with excellent visualization throughout the lower pole and ureteropelvic junction. It facilitates guidewire passage down the ureter and also favors good manipulations of the nephroscope and forceps within pelvicalyceal system. This is not the case when a tract

is established through lower calyx. Lower calyceal access requires undue angulations and torqueing. On the other hand, this disadvantage could be overcome by the use of a flexible nephroscope through a lower calyx which will offer greater accessibility without the need of extravagant manipulations.[14] Flexible cystoscope is most of the times able to reach the middle and upper calyces and inspect them for residual stones. Also, our choice to always perform a prone PCNL and access the kidney by a posterior lower calyx allow us to have access into the anterior ones and moreover into all lower calyces. Additionally, complication rates, especially those of thoracic problems and bleeding, are significantly more common during PCNL through the upper pole calyx compared with a lower calyx approach.[3] Regarding our series, 2 out of 103 studied patients were transfused due to bleeding (transfusion rate: 1.9% compared to 9% reported in CROES PCNL study) while no chest complications were observed. Moreover, prolonged hospital stay is reported in the upper calyx access cases.[3] Nevertheless, the mean length of hospitalization in our study is longer than the average one based on available bibliography. This paradox is due to 2 reasons. We have calculated as the onset of hospitalization the day before the procedure when the patient is undergoing the preoperative evaluation as we usually do in our department. Secondly, since our center is a referral center covering a very large geographical area and most of the patients come from a long distance, it is a routine practice for us to keep the patients one more day after the removal of the council catheter in order to evaluate for possible renal leak and other complications.

An indudibular access should always be avoided in order to prevent inadvert arterial trauma. Sampaio et al[15] reported that upper infundibulum is almost completely involved, both anteriorly and posteriorly, with segmental or interlobar arteries in 86.6% of cases, whereas in 62% of the cases the posterior aspect of the lower major calyceal infundibulum was free from arteries. Inadvertent infundibular puncture in the upper pole may have higher bleeding risk than lower pole. Sampaio et al[16] in another study reported that puncturing the upper pole infundibulum led to an interlobar vessel injury in two thirds of the cases, while only 13% of the patients had an arterial injury when lower pole infundibulum was punctured.

Taking into consideration the above, it seems that a PCNL technique which combines the safety of a lower calyceal access without compromising SFRs would be an ideal scenario for the management of staghorn calculi. According to our results, single lower percutaneous tract combined with flexible nephroscopy for the management of staghorn stones may provide great efficacy while it preserves a safety profile. Our stone –free rate of 65% seems acceptable especially when taking into concern the multicentric study (96 centers worldwide) study comparing outcomes of PCNL for staghorn vs. nonstaghorn stones by the clinical research office of the endourological society which included the largest series of patients so far (n=5335) and reported a 56.9% stone free rate for staghorn stones.[1]

The present study has some limitations that merit to be mentioned. It is limited by both its retrospective nature and being conducted at a single center. Although data

collection is prospective, our study may carry all the inherent potential issues associated with retrospective studies. Proper prospective studies with head-on comparisons are needed to prove or disprove the advantages and disadvantages of either approach.

Based on our knowledge, this is the first study presenting the results of percutaneous nephrolithotomy through a single lower calyceal tract combined with flexible nephroscopy for the management of staghorn calculi.

Conclusion

PCNL through a single lower calyceal tract combined with flexible nephroscopy can be a valuable treatment option for staghorn calculi combining efficacy and minimal morbidity.

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Figures and Tables

Table 1. Demographic data and stone characteristics	
Number of patients	103
Gender, n (%)	
Male	61 (59.2)
Female	42 (40.8)
Age, years	
Mean ± SD	53.3±14.8
Stone side, n (%)	
Right	40 (38.8)
Left	63 (61.2)
Stone burden, mm^2	
Mean ± SD	1106.8±1067.7
Hounsfield units	
Mean ± SD	1065.4±338.3
Stone radiopacity, n (%)	
Radiolucent	13 (12.6)
Radiopaque	90 (87.4)
Hydronephrosis, n (%)	
<Grade 2	58 (56.3)
≥Grade 2	45 (43.7)

SD: standard deviation.

Table 2. Intraoperative and postoperative outcomes	
Procedure duration, minutes	
Mean ± SD	141.3±52.6
Fluoroscopy time, seconds	
Mean ± SD	478.8±265.9
Length of hospitalization, days	
Mean ± SD	4.94±2.31
Postoperative complications, n (%)	
No	72 (69.9)
Yes	31 (30.1)
Clavien-Dindo categorization, n (%)	
Grade 0	72 (69,9)
Grade 1	14 (13.6)
Grade 2	11 (10.7)
Grade 3a	5 (4.9)

Grade 3b	1 (1.0)
Postoperative stone-free, n (%)	
No	36 (35.0)
Yes	67 (65.0)

SD: standard deviation.