Journal of Complementary Medicine Research, ISSN: 2146-8397 Vol. 14, No. 5, 2023 (pp.498-503)
RESEARCH ARTICLE WWW.JOCMR.COM

Efficacy and safety of Standard percutaneous nephrolithotomy for the management of staghorn calculi : A Single Centre experience.

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Abstract

Background: Staghorn stones are large branching stones that fill part of all of the renal pelvis and renal calyces and they can be complete or partial depending on the level of occupancy of the collecting system. Management of staghorn stone is still challengeable. There are seven alternatives for managing staghorn calculi, including: Medical therapy alone,
Open surgery, Anatrophic nephrolithotomy (AN),Chemolysis or stone dissolution therapy, Percutaneous nephrolithotomy (PNL),Shock-wave lithotripsy (SWL) ,Combination of PNL and SWL(sandwich technique) ,endoscopic combinedand intrarenal surgery (ECIRS)

Methods: This prospective single center cohort interventional study was carried out on 68adult patients having staghorn stone From June 2022 to June 2023.

Results: On univariate analysis, it was found that age, stone shape, Hounsfield unit (HU unit), complexity, staghorn stones, recurrence, and operative time were significant factors affecting SFR. While multivariate analysis found that operative time was significant factors affecting SFR

Conclusions: PCNL is the method of choice for treating staghorn stones, It should be done in a specialized center with facilities for the management of stones and treatment of any consequences.

Keywords: PCNL, PNL, staghorn, stone, percutaneous nephrolithotomy

DOI: 10.5455/jcmr.2023.14.05.50

Introduction:

Staghorn calculi are branching stones that dominate the collecting system. They usually fill the renal pelvis and branch into a few or all of the calices. The phrase "partial staghorn" calculus refers to a branched stone that occupies a portion but not the entirety of the collecting system, and "full staghorn" calculus refers to a stone that occupies nearly the entire collecting system[1].

Up to date, there is no agreement on the precise definition of staghorn calculus, such as the number of involved calices required for a staghorn designation; as a result, the term "staghorn" is frequently used to refer to any branched stone occupying more than one portion of the collecting system, i.e., renal pelvis with one or more caliceal extensions. Furthermore, the terms "partial" or "full" staghorn calculus do not imply any volume criteria [2].

The aim of treatment of staghorn stone with percutaneous nephrolithotomy to achieve the best Stone clearance rate with minimal morbidity, fewer complications, shorter hospital stay& lower blood transfusion requirements. Clayman et al in 1983 reported the safety & feasibility of percutaneous nephrolithotomy for staghorn stone treatment. Currently, PCNL is a proper choice for staghorn renal stones [3].

Despite recent refinements to the technique and instrumentation of PCNL for the treatment of staghorn calculi, the number of PCNL procedures remained stable over the years and these stones are still a troublesome challenge for endourologists and are associated with a higher rate of perioperative complications than that for non-staghorn disease[4]

Patients and Methods:

This prospective single center cohort interventional study was carried out on 68 adult patients having staghorn stone with Split renal function more than 20% and Fit for anesthesia and surgical procedure From June 2022 to June 2023 .

The study was done after approval from the Ethical Committee Kafr-Elsheikh University Hospitals. An informed written consent was obtained from the relatives of the patients.

Exclusion criteria were Raised serum creatinine, Active infection, Coagulopathy, Pregnancy, Pulmonary or cardiac disease, Morbid obesity, Comorbidities and unfit for surgery, Atrophic kidney or split function less than 20% and Untreated urinary tract infection.

All patients were subjected to complete history taking, general examination, laboratory tests (CBC, serum creatinine, C reactive protein, bleeding and clotting time, urine analysis, liver function and prothrombin time and concentration (PC)), vital sign: (Blood pressure , heart rate , respiratory rate and body temperature), imaging **(** abdominal ultrasound, Computed tomography and malrotated kidneys Intravenous urography (IVU) was done**)**. All patients were fasting 8 hours preoperatively and intravenous (IV) cephalosporins two hours before the surgery.

Surgical technique: With endotracheal intubation, all patients were operated under general anesthesia. An ipsilateral ureteric catheter was inserted with the patient in a lithotomy position. Percutaneous access was made after fixation of the ureteric catheter in the prone position with flank is slightly elevated by a small pillow under the upper abdomen to make the back flat, using multidirectional C-arm fluoroscopy guidance after opacification of the renal pelvicalyceal system by Iodinated contrast in a retrograde fashion. The surgeon, assistant, nurse, and the lithoclast stand at the side of the stone, looking at the C-arm monitor and Endoscopic monitor on the other side of the table.

The skin puncture was done using an18-gauge coaxial ship needle at the posterior axillary line towards the posterior lower calyx. All tracts were made and guidewires were secured inside the calyceal system before dilatation of either tract. We performed dilatation with Amplatz dilators up to 30 French for the main preferred tract where a rigid nephroscope of 26F (WOLF) was used through an Amplatz sheath. In some cases, the dilatation of secondary tracts was done according to the shape of the stone. Stone disintegration with pneumatic lithotripters and extracted through the nephroscope using forceps and mechanical suction. Confirmation of stone-free status virtually and under fluoroscopy. Ureteric catheter left as a stent when the session was finished, but -if indicated- a ureteric catheter is replaced with a DJ stent inserted in an antegrade fashion. 22 French nephrostomy tube was placed in the main track while 20 French nephrostomy tubes were placed in any further tracts and all the tubes were closed till the next morning. Intraoperative procedure time, the number of access tracts, access calyces, need for blood transfusion and any intraoperative complications were recorded. Operative time was defined as the time from the introduction of the ship needle into the skin of the patient to the placement of the nephrostomy tube.

Post-operative assessment:The patients were allowed to resume oral feeding 4 hours postoperatively. The closed nephrostomy tube was opened 24 hours postoperatively, PUT or non-contrast CTU was then performed. Nephrostomy tubes were removed routinely after confirmation of a stone-free state. The ureteric catheter was removed on the second day postoperatively. DJ was removed after 1 month postoperatively. In patients with residual stones that needed second look PCNL, Ureteric catheter and nephrostomy tube were left till the second look which was done 1 week later. The postoperative Hemoglobin level was evaluated. The length of hospital stay, postoperative transfusion, and any early or late complications was recorded.

Statistical analysis

Normality distribution for quantitative variables was tested by the Kolmogorov–Smirnov test ($P > 0.10$). For categorical variables, Chi-square test, Fisher's exact test or McNemar test were applied as appropriate. Comparison of continuous variables between the two groups was conducted with Student's t test or Mann–Whitney U test depending on Gaussian distribution. To compare data from three or more patient groups, we applied the one-way analysis of variance (ANOVA), and, when indicated, the Student–Newmann–Keuls method was used as a post hoc test.

Normally distributed data are expressed as mean ± SD, while non-normal distributed as median [25th–75th IQR]. All statistical analyses were performed using SPSS 19.0 software (IBM SPSS, USA); two-tailed P values <0.05 were considered statistically significant. **Results:**

A total of 68 patients underwent PCNL; their preoperative patients' characteristics are summarized in Table 1.

Table 1: Demographic and clinical characteristics of the study group undergoing Percutaneous Nephrolithotomy for Staghorn Calculi:

Variables	**PCNL (n=68)**
Age* Mean (SD)	**53±13.4**
Gender#	

Female	**37 (54.4%)**
Male	**31 (45.6%)**
BMI*	**21 (0.56)**
Hb*	**11.7 + 0.32**
Medical history#	
Hypertension	**11 (16.2%)**
Diabetes mellites	**22 (32.4%)**
Surgical history#	
PNL	**2 (2.9%)**
SWL	**2 (2.9%)**
Open Surgery	**1 (1.4%)**

*Data are presented as mean (SD). #Data is presented using N (%)

Regarding kidney and stone characteristics among the included patients undergoing Percutaneous Nephrolithotomy for Staghorn Calculi. Table2

Table 2: kidney and stone characteristics among the included patients undergoing Percutaneous Nephrolithotomy for Staghorn Calculi:

Variables	**PCNL (n=68)**
Stone side#	
Right	**35 (51.5%)**
left	**33 (48.5%)**
Stone shape#	
Complete staghorn	**16 (23.5%)**
Partial staghorn	**52 (76.5%)**
Stone number#	
Single	**31 (45.6%)**
Multiple	**37 (54.4%)**
Hydronephrosis#	
No	**32 (47.1%)**
Mild	**24 (35.3%)**
Moderate	**6 (8.8%)**
Marked	**6 (8.8%)**

#Data is presented using N(%)

Operative time :The mean operative time was 128 + 6.23. The mean creatinine change was 0.176 + 0.17. Regarding hospital stay, the mean hospital stay was 5.7 + 0.69 days. Moreover, the mean recover time was 4.4 + 0.43.table 3

Table 3: Operative time and perioperative changes across the included patients undergoing Percutaneous Nephrolithotomy for Staghorn Calculi:

Variables	**PCNL (n=68)**
Operative time#:	**128 (6.23)**
Creatinine change#	**0.176 (0.17)**
Hospital stay#	**5.7 (0.69)**
Recovery time#	**4.4 (0.43)**

#Data are presented as mean (SD).

Complications undergoing Percutaneous ephrolithotomy for Staghorn Calculi: Data analysis showed that 5 (7.4%) patients experienced bleeding, 5 (7.4%) patients experienced pleural injury, and 4 (5.9%) patients experienced renal pelvic injury. Regarding the postoperative complications, 7 (10.3%) patients experienced fever, 8 (11.8%) patients experienced wound infection, 1 (1.5%) experienced urine leakage, and 8 (11.8%) patients experienced transfusion. Regarding postoperative grades, 41 (60.3%) were grade 0, 11 (16.2%) patients were grade 1, 12 (17.6%) patients were grade 2, and 4 (5.9%) patients were grade 3.table 4

Table 4: Operative time and perioperative changes across the included patients undergoing Percutaneous Nephrolithotomy for Staghorn Calculi:

Complications	PCNL (n=68)
Intraoperative complications	
Bleeding	5 (7.4%)
Pleural injury	5 (7.4%)
Renal pelvis injury	4 (5.9%)
Postoperative complications	
Fever	7 (10.3%)
Wound infection	8 (11.8%)
Urine leakage	1 (1.5%)
Transfusion	8 (11.8%)
Postoperative grades (modified Clavien)	
Grade 0	41 (60.3%)
Grade 1	11 (16.2%)
Grade 2	12 (17.6%)
Grade 3	4 (5.9%)

*Data are presented as N (%).

Post operative assessment and outcome in the included patients undergoing Percutaneous Nephrolithotomy for Staghorn Calculi: After the first session of PCNL procedure, 55 (80.9%)cases were rendered stone free (with residual fragments ≤4 mm) and 9 (13.2%) cases had residuals. ESWL was performed for 13 (19.1%) cases with residual stones, 10 cases of them rendered stone free post-ESWL. table 5

Table 4: Post operative assessment and outcome in the included patients undergoing Percutaneous Nephrolithotomy for Staghorn Calculi:

Variables	PCNL (n=68)
Need for auxiliary procedures	
No	54 (79.4%)
SWL	12 (17.1%)
Need for 2nd look PCNL	1 (1.4%)
Residual stone	9 (13.2%)

*Data are presented as N (%).

Discussion

The aim of treatment of staghorn stone with percutaneous nephrolithotomy to achieve the best Stone clearance rate with minimal morbidity, fewer complications, shorter hospital stay& lower blood transfusion requirements. Clayman et al in 1983 reported the safety & feasibility of percutaneous nephrolithotomy for staghorn stone treatment. Currently, PCNL is a proper choice for staghorn renal stones.[3]

Regarding the stone shape, 52 (76.5%) had partial staghorn stones, while 16 (23.5%) patients had partial stones. This was comparable with the study done by Fathallah et al., as nineteen cases (59.4 %) stones were classified as partial staghorn stones and thirteen cases (40.6%) as complete staghorn .[5]

Thirty-seven patients (54.4%) had multiple stones, while 31 (45.6%) had single stone. This was comparable with the results reported by Gadelmoula et al., as 138 (60) patients had multiple stones, while 92 (40) patients had single stone.[6]

Regarding the postoperative complications, 7 (10.3%) patients experienced fever, 8 (11.8%) patients experienced wound infection, 1 (1.5%) experienced urine leakage, and 15 (22%) patients experienced transfusion. This was comparable to the results of El-nasr et al., where 2 (8%) patients experienced fever, 2 (8%) patients experienced wound infection, 1 (4%) experienced urine leakage, and 4 (16%) patients needed transfusion .[7]

Regarding postoperative grades, 41 (60.3%) were grade 0, 11 (16.2%) patients were grade 1, 12 (17.6%) patients were grade 2, and 4 (5.9%) patients were grade 3. This was comparable to the study done by El-nasr et al., where 64% of his patients were Grade 0, 16% were Grade 1, 16% were Grade 2, and 4% were Grade3 .[7]

Stone clearance rates after percutaneous nephrolithotomy for staghorn stones were reported by Al- kohlany being 49% - 78% reported by Soucy . In this series, the stone clearance was 80.9%. The stone clearance rate of 49% was reported by Al-Kohlany because they were treating complete staghorn stones, while we included complete and partial staghorn stones.[8], [9]

Stone free rate in the current study is higher than that by El-Nahas et al, which was 54%.[10] It is nearly like the results of Soucy et al, which was 78%).[9]

The mean operative time in current study is (128 minutes±6.23 SD) which is shorter than that by Weiwen Yu et al, who reported mean operative time of (130 minutes).[11] Recurrent stones (7.2%) were an important cause of the prolonged time of PCNL due to difficulties in tract dilation in scarred perinephric spaces and collecting system and cautious fixation of kidney in the retroperitoneum. All recurrent cases in the study especially those with higher stone burdens were operated by experienced senior endocrinologists who are operating more than 20 cases per month. Multiple tracts were used in these cases.

It is an important point to make a good Patient explanation before Percutaneous nephrolithotomy as there is a 1.4% another session PCNL and 19.1% auxiliary procedures were needed in this series which is less than El-Nahas et al 2012 who reported 30% another session PCNL and 21% auxiliary procedures, Duvdevani et al, 2007 where it was 24.7% in the study done by Nguyen Phuc Cam H in 2010.[10][12]

The patients must be informed that the chance of needing multiple interventions to become stone-free might be up to 50%. Potentially significant morbidity or death was reported with PCNL in large scale series [17]. Fortunately, no deaths occurred in this series. The hospital stay in this series was (4-8 days) which is within the range of others.

A staghorn stone was identified to be a risk factor for severe bleeding after percutaneous nephrolithotomy, and multiple tracts were also detected as a risk factor for bleeding during PCNL.[13] Bleeding is the most frequent complication of PCNL. Excessive bleeding can occur during any step of the procedure like needle passage and tract dilatation.[14] Intraoperative bleeding that require blood transfusion has been reported in 3% to 12% of cases, and 0.8%-30.9% .[15]

Transfusion in the current study was 22%, which is close to the rate reported by Nguyen Yu (25%).[11]It was 30% in the study done by Singla et al,.[16] In this study, no selective embolization required or nephrectomy. The most often injured organs during PCNL and stone removal are the lungs and pleura, with possible hydrothorax or pneumothorax. We had 5 (7.4%) plural injuries and 4 (5.9%) renal pelvic injuries.

Bowel perforation occurred in one patient (1.4%) in this study and ileostomy done for the patient after one week postoperative. In 1983, Vallancien et al. reported 2 cases with perforation of the left colon among a series of two hundred and fifty percutaneous nephrolithotomies, these two patients were treated surgically.[17] El-Nahas et al. retrospectively reviewed 5039 PCNLs (from 1985 to 2004) and reported 15 (0.3%) colonic perforations.[18]

A staghorn guidelines panel reported complication rates of 7–27% and a postoperative transfusion rate of 18%.[19] The complication rate of 22.1%, postoperative transfusion rate of 7.4% were the results in this study. Angiographic embolization was not needed; it was encountered in 3.4% of patients in El-Nahas et al.2012 .[10]

Stone position and stone branches in collecting system were evaluated using Non-contrast CTU or Intravenous Urography (IVU). Non-contrast CTU is important in planning the PCNL access.[3] Complete clearance of the stone is a must to eradicate any causative organisms, to relieve obstruction, and to prevent further stone growth.[19] This would be achieved by using multi-tract PCNL, flexible nephoscopy during the first or second session PCNL, or ESWL to treat residual stones . [3]

Conclusions:

PCNL is the method of choice for treating staghorn stones, It should be done in a specialized center with facilities for the management of stones and treatment of any consequences. The patients should be informed about the stone-free rates, possible complications, and the possibility of multiple sessions or auxiliary procedures.PCNL is a safe and effective choice for the treatment of staghorn stones with high stone-free rates and minimal morbidity.

Limitation of study: This study has some limitations such as the descriptive design (no control), the use of flexible nephroscope to survey the calyces was not the protocol, and scoring systems were not applied. We also didn't have the data of stone constituent, which had a role in the curative effect, especially for the residual stones, and there was no standard method for reporting the burden of staghorn stones.

Financial support and sponsorship: no

Conflict of Interest:no conflict of interest

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