Original Article

Percutaneous nephrolithotomy versus open surgery in patients presenting with renal staghorn stones: A single-center study

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Objective: To compare the efficacy of percutaneous nephrolithotomy (PCNL) with open surgery for the treatment of renal staghorn stones in our setting.

Methodology: This prospective interventional study was conducted at AIMS, Hyderabad, from January to October 2019. We included 70 patients presenting with complete staghorn stonesusing non-probability consecutive sampling technique. Stone clearance rate, postoperative complication rate, mean operative time, hospitalization days and culture on follow-up were compared for both methods.

Results: Mean age of patients was 44.8 ± 8.7 years (range 24 – 63). PCNL provided an overall stone clearance rate of 80%; 84% for partial staghorn stones while 70% for complete staghorn stones. In open surgery group, an overall stone clearance rate was 85.7%; 94% for partial staghorn stones and 77% for complete staghorn stones. Postoperatively, out of the 35 patients who underwent PCNL, 1 (2.9%) had a wound infection, 6 (17.1%) had leakage and 1 (2.9%) experienced uropathy. Amongst the patients who underwent open surgery, 2 (5.7%) had wound infection, and 2 (5.7%) had leakage (p = 0.307).

Conclusion: PCNL was a very effective treatment modality for both partial and complete branching staghorn stones in our setting. The stone clearance rate for PCNL was as high as that of open surgery with low mean operative time, reduced hospitalization days, and a better overall outcome.

Keywords: PCNL, struvite, staghorn, urinary tract calculus.

INTRODUCTION

Staghorn calculi are hefty branching stones that completely or partially occupy the renal pelvis and renal calyces.[1] Such stones are more common in women compared to men and they are usually unilateral. The staghorn stones are called struvite stones and are composed of magnesium, ammonium, and phosphate.[2] Staghorn stones are strongly correlated with urinary tract infection caused by urease-producing organisms, including; Proteus, Klebsiella, Pseudomonas, and Staphylococcus bacteria.[3,4]

There is a high rate of morbidity and mortality associated with staghorn calculi, hence quick diagnosis and treatment is essential. Nevertheless, the conservative treatment has reported a mortality rate of 28% in 10-year period and 36% risk of developing significant renal dysfunction.[5] Therefore, new treatment modalities including extracorporeal shock wave lithotripsy and Percutaneous nephrolithotomy (PCNL) are being explored that are minimally invasive and are reported to be effective against these stones.[6]

PCNL is the treatment of choice for the management of staghorn stones that are refractory to conservative management.[7] The procedure has reduced morbidity and mortality and associated with a high stone clearance rate. Nevertheless, large, complete renal staghorn calculi often present a formidable challenge to the percutaneous endourologist.[8] The stone clearance rate, complication rates, short-term and long term-outcomes are associated with the experience level of the surgeon and others factors including age, partial or complete stone, or presence of other concomitant morbidities.[9,10] To this date, there is a lack of unison among urologists regarding treatment of staghorn stones. This study compared the success rates of PCNL and open surgery for the treatment of staghorn calculi in a tertiary care hospital in Pakistan.

METHODOLOGY

The study included 70 patients who were treated for partial and complete staghorn stones between January and October 2019 at AIMS, Hyderabad. They presented with flank pain, lower urinary tract symptoms, fever, or hematuria were treated with PCNL or open surgery. Equal number of patients were assigned to PCNL and open surgery groups via closed envelope randomization sampling technique.

All patients between the ages of 20 to 65 years, normal BMI, and normal creatinine levels were included in the study. Patients with age over 65 years and those with

morbid obesity, recurrent stone formation, congenital kidney malformation, deranged clotting profile, and end stage renal disease were excluded from the study. Ethical approval was obtained from the institutional reviewcommittee of AIMS hospital (Ref IRB number of AIMS/ERCL/6519/19).

A thoroughhistory, clinical examination and routine laboratory investigations, radiological evaluation including plain abdominal radiography (KUB) and ultrasonography (US) was conducted. A standard PCNL was performed with general anesthesia for 35 patients. Access to the kidney was achieved through 1 puncture in 33 patients, 2 punctures in 2 patients. In cases where the stone was large, it was first broken into fragments and then removed via stone grasper.In faint opaque and lucent stones non-contrast spiral CT was performed. The stones were retrieved by pyelolithotomy and nephrolithotomy.

Postoperative evaluation, stone clearance rate at discharge home and hospital stay were recorded. Patients who were completely cleared of stones were considered stone free. All patients were regularly followed every 3 months during the first year and every 6 months thereafter. At each visit, they were asked about the time required to return to normal activities. GFR were performed in all patients at least once during follow-up, which ranged from 3 to 14 months with a mean of 4.9-2.5 months.

Statistical Analysis: Data were analyzed in SPSS version 25. Independent t-test was used to find significance in continuous variables while chi square test was used to determine the significance of categorical variables including the type of stone, age groups, etc. A $p < 0.05$ was considered statistically significant.

RESULTS

Mean age of patients was 44.8 ± 8.7 years. The PCNL group comprised 25 (71.4%) partial and 10 (28.6%) complete staghorn stones while the open surgery group had 17 (48.5%) partial and 18 (51.4%) complete staghorn stones. In the PCNL group, mild hydronephrosis was seen in 14 (40.0%) patients, moderate hydronephrosis was observed in 14 (40.0%) patients, and in 7 (20.0%) patients, severe hydronephrosis was observed (Table 1).

PCNL provided an overall stone clearance rate of 80%, 84 percent for partial staghorn stones while 70 percent for complete staghorn stones (Fig. 1). Postoperatively, the blood culture test was positive in 6 (17.1%) patients who underwent open surgery ($p<0.012$). In 27 (77.1%) patients from PCNL group and 31 (88.6%) patients in

Table 1: Demographic and clinical profile of patients (n = 70).

Variable	PCNL Group	Open Surgery Group	p-value
Gender			
Male	18 (51.4%)	18 (51.4%)	0.587
Female	17 (48.6%)	17 (48.6%)	
Stone type			
Partial	25 (71.4%)	17 (48.5%)	0.566
Complete	10 (28.6%)	18 (51.4%)	
Hydronephrosis			
Mild	14 (40.0%)	12 (34.3%)	0.421
Moderate	14 (40.0%)	19 (54.3%)	
Severe	7 (20.0%)	4 (11.4%)	
Mean Operative time ± SD *(in minutes)*	132 ± 26	215 ± 33	0.09
Blood Culture			
Positive	0 (0.0%)	6 (17.1%)	0.012
Negative	35 (100.0%)	29 (82.9%)	
Mean Hospital Stay ± SD *(in days)*	2.9 ± 0.3	3.5 ± 0.57	0.001
Postoperative complications			
None	27 (77.1%)	31 (88.6%)	0.307
Wound Infection	1 (2.9%)	2 (5.7%)	
Leakage	6 (17.1%)	2 (5.7%)	
Uropathy	1 (2.9%)	0 (0.0%)	

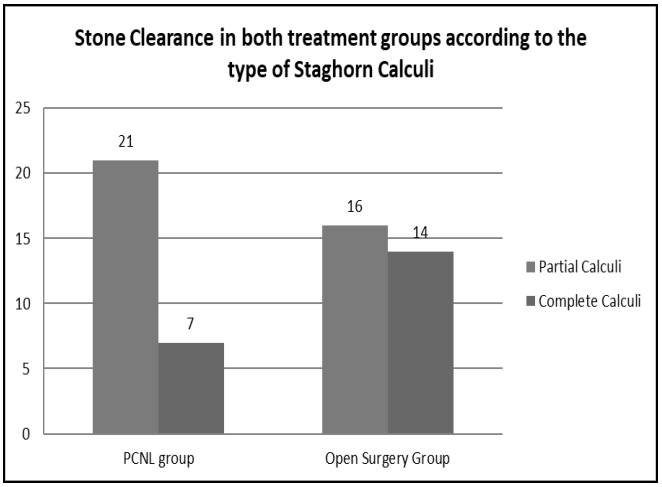

Fig. 1: Stone clearance in both treatment groups with Staghorn calculi (p = 0.08).

Table 2: Association of age with stone clearance rate.

Age	Stone Clearance PCNL Group		p-value	Stone Clearance Open Surgery Group		p-value
	Positive (28)	Negative (7)		Positive (30)	Negative (5)	
< 46 years	25 (89.3%)	-	0.000	6 (20%)	-	0.366
> 45 years	3 (10.7%)	7 (100%)		24 (80%)	5 (100%)	

open surgery group, no postoperative complications were observed (Table 1). In the PCNL group, age was significantly correlated with the stone clearance rate ($p < 0.0001$) (Table 2).

DISCUSSION

Since the transformation of endoscopic devices and techniques, many new minimally invasive procedures have been introduced. Miniaturization of endoscopic devices enhances the visualization, making it easier to treat the renal calculi without increasing risk of bleeding and need of transfusion.[11-13] Nevertheless, successful PCNL depends on many factors; the type of staghorn stone, the morphology and concomitant infection can significantly affect the clearance rate of stones and overall outcomes of PCNL.[14]

Therefore, only the most experienced surgeons prefer the PCNL procedure for the treatment of staghorn calculi for their patients. In contrast, open surgery is not affected by the morphology or the type of renal calculi, making it very easy for even the younger surgeons to perform. In the present study, we compared the effectiveness of PCNL versus open surgery as the treatment modality for partial and complete staghorn stones in the Pakistani population.

A meta-analysis by Chen et al consisting of 10 studies comparing the efficacy and safety of PCNL with open surgery for patients with staghorn calculi reported a significantly lower immediate stone free rate with PCNL as compared to patients who underwent open surgery with odds ratio of 0.29; 95% CI: 0.16, 0.51; $p < 0.0001$.[15] Our results are similar where a stone clearance rate of 80% was observed with PCNL procedure while a higher rate of 85.7% in patients who underwent open surgery for retrieval of staghorn calculi. However, the difference was statistically non-significant ($p = 0.376$). The meta-analysis concluded that overall there was no significant difference in stone clearance rates between the two techniques with odds ratio of OR: 1.17; 95% CI: 0.64, 2.15; $p = 0.61$.

In the present study, a higher rate for minor complications was observed in patients who underwent PCNL procedure compared with patients who underwent open surgery ($p = 0.307$). This could be explained by the surgeon's greater level of expertise in open surgery and the fact that PCNL is still a novel approach in our setting, which requires a lot of experience to completely master this minimally invasive procedure. In contrast, others reported that PCNL was associated with much lower overall complication rate (R: 0.59; 95% CI: 0.41, 0.84; $p = 0.004$).[15,16]

We observed a shorter mean operative time for PCNL compared with open surgery; 132 ± 26 minutes and 215 ± 33 minutes, respectively ($p = 0.09$). Our study findings are similar to a study by Al Kohlany et al, who reported a significantly shorter operative time for PCNL group compared with open surgery (127 ± 30 vs. 204 ± 31 minutes, ($p = 0.001$) as well as less number of hospitalization days (6.4 ± 4.2 vs. 10 ± 4.2 days, ($p = 0.001$).[17]

CONCLUSION

Our study suggests that PCNL is a safe and effective procedure with an almost equal stone clearance rate as that with open surgery with only minor complications, reduced number of hospitalization days, lower mean operative time, and reduced incidence of postoperative infections.

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Conception and design: Imran Memon, Naveed Soomro.
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Drafting of the article: Imran Memon, Naveed Soomro.
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