Safety of Minimally Invasive Percutaneous Nephrolithotmy in High Risk Patients in Lateral Position - A Single Center Study

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ABSTRACT

Objective: To assess the safety and efficacy of minimally invasive percutaneous nephrolithotomy with fluoroscopy aided renal access in the lateral position, in patients who were high-risk cases for anesthesia in prone position.
Study Design: Prospective observational study.
Place and Duration of Study: Armed forces institute of Urology, Rawalpindi, from Jan 2018 to Dec 2019.
Methodology: Fifty-three patients with renal stones >1.8cm underwent minimally invasive percutaneous nephrolithotomy with fluoroscopy-guided renal access in the lateral position. All the patients were obese, some had severe ischemic heart disease, few had diabetes mellitus. All the patients were unfit for the prone position.
Results: Successful renal access was achieved in all the patients (100%). The mean size of stone was 28 + 13.2 mm, with an average operative time being 55 ± 13.56 minutes and the mean hospital stay was 1.8 ± 2.3 days (range 2-4 days). No visceral or pleural injuries were documented. In addition, only two patients required postoperative transfusion. After procedure, the rate of complete stone clearance initially was 90.6%, which improved to 96% after single session of extracorporeal shockwave lithotripsy (ESWL). Only 2 (3.77%) patients had persistent residual stone fragment.
Conclusion: Minimally invasive percutaneous nephrolithotomy with fluoroscopy-guided renal access in the lateral decubitus flank position, is safe and convenient in high-risk patients where prone position is contraindicated.

Keywords: Fluoroscopy aided renal access, Minimally invasive percutaneous nephrolithotomy, Nephrolithiasis, Prone position.

How to Cite This Article: *Kmizar S, Nawaz M, Farooq U, Shehzad K, Murtaza B, Akmal M. Safety of Minimally Invasive Percutaneous Nephrolithotmy in High Risk Patients in Lateral Position-A Single Center Study. Pak Armed Forces Med J 2022; 72(1): 202-206. Doi: https://doi.org/10.51253/pafmj.v72i1.4087*

INTRODUCTION

Urolithiasis is considered to be the most common urological problem encountered by urologists worldwide. Urinary stones have been documented to cause renal dysfunction ultimately leading to poor quality of life and the need of renal replacement. Over the time, with the advancement in urological instruments and a better learning, there has been a shift from open surgeries to minimally invasive techniques in the management of stone disease.[1] Percutaneous nephrolithotomy (PCNL) has become the standard in the treatment of renal and upper ureteric stones. Over the past two decades, there have been advancements and improvement in percutaneous nephrolithotomy; from PCNL to tubeless and mini PCNL. The first ever tubeless procedure was performed in 1997.[2,3]

Percutaneous nephrolithotomy (PCNL) had undergone evolution over the past decades. Main disadvantage of standard PCNL is using large sheath of 32FR, which could be very traumatic, associated with the risk of complications like parenchymal or visceral injury, bleeding and perforation. Therefore standard PCNL has been replaced by mini PCNL.[4] The outcomes of PCNL are thought to be influenced by the patient's body habitus, complex renal anatomy which may affect the feasibility of renal access and the efficacy of the procedure.[5]

Percutaneous renal access can be achieved in prone, supine or lateral position. Lately the supine and lateral positions have become more popular. However among many urologists across the world, prone position is still famous as it allows the surgeon to choose suitable place of renal puncture over wide surface area.[6] However, in patients with high body mass index, poor respiratory reserve, ischemic heart disease with low ejection fraction, prolonged prone position would be poorly tolerated. In individuals with structural deformities like kyphoscoliosis, or fixed flexion deformity of lower limbs, positioning for PCNL can be extremely difficult.[7,8] Supine position under local anesthesia would be ideal for these patients however it is associated with poor ergonomics because the downward positioning of renal tract, demands expertise.[9,10] Lateral position has been found to be better tolerated in the high risk patients with good outcome.

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Received: 28 Apr 2020; revision received: 28 Jul 2020; accepted: 28 Jul 2020

Despite the evolution and development in instruments, the lateral approach is still not very popular in our setup. We present in this study our experience with mini PCNL in lateral position under fluoroscopy guided renal access and its feasibility in patients with multiple comorbids who were high risk for anesthesia in prone position.

METHODOLOGY

A prospective observational study was conducted at Armed Forces Institute of Urology (AFIU), after approval from the Ethics Committee (IRB ref. number: URO-ADM-TRG-1/IRB/2016/105) from January 2018 to December 2019.

Inclusion Criteria: Patients with renal stones, requiring mini percutaneous nephrolithotomy in lateral decubitus position, not suitable for anesthesia in prone position, either due to their BMI or other medical reasons were included in the study.

Exclusion Criteria: Patients with upper pole not dilated, congenital anomaly, bleeding diathesis, untreated urinary tract infection or radiolucent stones were excluded.

After the informed consent these patient were included in the study. Demographic details, BMI, ASA score, details of associated comorbidities were noted. Pre-operatively CT urogram and intravenous urogram were not carried out, only non-contrast CT KUB was performed. For planning purpose, intra-operative pyelography was done with the help of open end ureteric catheter placed at the start of the procedure to highlight the calyceal anatomy. Laboratory investigations including urine culture, serum electrolytes, creatinine levels, hemoglobin and coagulation profile were performed. Any history of urinary tract infections was noted and patients with active infections or positive urine culture were treated with antibiotics and procedure was carried out once urine culture was negative for any bacterial growth.

Total of 53 patients underwent mini PCNL in lateral decubitus position. After the induction of general anesthesia, patient was draped in lithotomy position, using 22 FR (French) cystoscope a 4 FR openend ureteric catheter was placed. The position of the catheter was confirmed using fluoroscope and ascending pyelography was performed to delineate the renal calyceal anatomy. Patient was then shifted to lateral position: thorax and pelvis were placed in lateral position. Abdominal fat was supported with soft pads, legs were flexed at knees, separated and supported with soft pads. The preferred technique of puncture in most cases was biplanar fluoroscopic access with C arm at 0 degrees, while in some cases bull's eye technique was utilized. The lower posterior calyx was highlighted using air and contrast injected through open end ureteric catheter and was punctured in majority of the cases. 18-G needle was used for calyceal puncture and once urine drops were observed through the needle, a 0.035-mm J-tipped guide wire was inserted through the puncture into the pelvis. Dilatation of the tract was initially performed with the fascial dilator then single step 15FR metallic dilator was used over a central rod and 17 french MINI PCNL sheath was passed. Once sheath was in place nephroscope was introduced and stone was visualized, pneumatic lithoblast was used and stones were fragmented and removed. Any respiratory complications, difficulty in intraoperative ventilation, or development of pneumothorax were noted. After stone clearance, a ureteric catheter was left in all the patients. On first post operative day x-ray KUB was performed for stone clearance and ureteric catheter was removed at the time of discharge.

The data was collected in the structured proforma. SPSS version 22 was used for data analysis.

Figure-1 & 2 showed the intra-operative puncture with patients in lateral position and their end of surgery wound and lateral position.

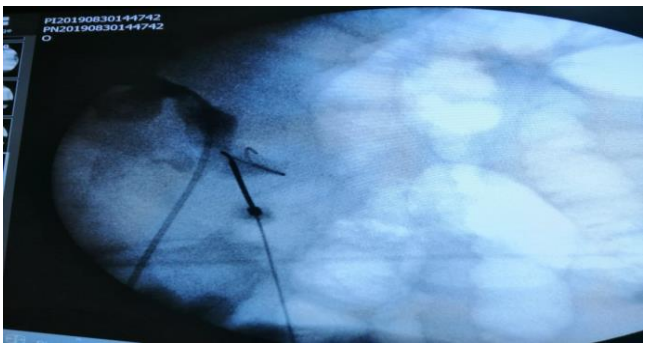

Figure-1: Puncture under flouroscopy: guidewire and ureteric catheter can be seen.

Figure-2: At the end of mini PCNL in lateral position.

RESULTS

Over the duration of 2 years, 53 patients were unfit for prone position. Due to high-risk medical issues; these patients underwent mini percutaneous nephrolithotomy in lateral position. Out of 36 (67.9%) patients were females while 17 (32.1%) were male with an average body mass index 38.4 ± 26. Seven patients had the history of previous open surgery, with recurrent stone formation. Mini PCNL in lateral position was carried successfully with single puncture in all 53 patients. Table-I showed the demographic detail of study population and their stone characteristic. Majority had Guy's class 1 stones, with mean size of 28 mm.

Table-I: Demographic detail and stone characteristics.

Parameters	n (%)
Mean age	40.3 ± 26 years
Gender	
Male	17 (32.1%)
Female	36 (67.9%)
Stone Type	
Staghorn-Partial	14 (26.4%)
Nonstaghorn	39 (73.6%)
Classification: (Guy's)	
1	26 (49.1%)
2	11 (20.7%)
3	7 (13.2%)
4	9 (17.0%)
Mean stone size	28 mm (± 13.2)
Mean BMI	38.4 ± 11.7
Previous open surgery	7 (13.2%)

Table-II showed the frequency of severe COPD 14 (26.4%) and Ischemic heart disease 21 (39.6%) which were risk factors for prone position. BMI was categorized according to the WHO criteria; majority patients were in class I and II of obesity. All the patients had high BMI which was considered a risk factor for poor compliance due to decreased FVC in prone position. Intra operative successful renal access was achieved with fluoroscopic guidance with mean operative time (from prick to stitch) of 55 ± 13.56 minutes. There was complete clearance in 48 (90.6%) cases, only 5 patients had residual calculi (6-11mm). In these patients a trial of post-operative ESWL was given after 2 weeks of initial PCNL, it was successful in 3 (5.6%) patients, while 2 (3.8%) has persistent fragments till follow up period at 3 months.

Table-III showed the post-operative summary of patients, only two patients required post-operative blood transfusion, the average haemoglobin in the post -operative period was 10.20 ± 2.6 g/dl. The mean hospital stay was 1.8 ± 2.3 days (2-4), all the patients were discharged on oral antibiotics for 5 days.

Table-II: Comorbid conditions and weight classification.

Comorbid Conditions	n (%)
Severe COPD/Asthma	14 (26.4%)
Severe IHD (EF<40)/HTN	21 (39.6%)
DM/HTN/IHD	9 (16.9%)
Obesity	
Overweight (25-29kg/m^2)	5 (9.4%)
Class I (30-34 kg/m^2)	13 (24.5%)
Class II (35-39 kg/m^2)	26 (49.1%)
Class III (>40kg/m^2)	9 (17.0%)

Table-III: Post-operative summary of patients.

Parameters	n (%)
Preoperative Haemoglobin (g/dl) (Mean ± SD)	12.40 ± 3.1
Postoperative Haemoglobin (g/dl) (Mean ± SD)	10.20 ± 2.6
Hospital stay (Mean ± SD)	1.8 ± 2.3 days
Mean Time from prick to stitch (mins) Mean ± SD	55 ± 13.56
Radiation Time (sec)	60-120
Complete Clearance	48 (90.6%)
Clearance after ESWL	3 (5.6%)
Persistent fragments	2 (3.8%)
Post op Complications	
Clavein dindo Class I	7 (13.2%)
Class II	2 (3.77%)

The rate of complications, according to the Calvein dindo classification showed 7 patients had class I complication with 4 patients developing fever on first post-operative day and needed to be treated with intravenous antibiotics for 5 days and only two cases had minimal mucosal injury. These two patients had history of previous open surgery and the renal anatomy was slightly complex. None of our patients needed post-operative ventilatory support. There was no case of pneumothorax, pneumonia or myocardial infarction and no perioperative mortality was documented.

DISCUSSION

Mini PCNL has become a routine procedure in our country. Our described the efficacy and feasibility of mini PCNL in lateral decubitus position in high-risk patients who were medically declared unfit for prone position or in whom supine access could be very challenging due to poor ergonomics associated with downward positioned renal tract or in whom the only other option would be open surgery. In such high-risk patients, we found this procedure to be associated with short hospital stay, with less pain, less post-operative morbidity and early return to the routine life as compared to open procedures.

Over the last few decades, open surgery for staghorn or non-staghorn calculi has been replaced by percutaneous nephrolithotomy (PCNL). PCNL has been performed traditionally in prone position,[11] but a relative contraindication to PCNL in prone position is high BMI or when cardiopulmonary stress is poorly

tolerated, that is the reason many authors are now recommending lateral decubitus position with minimal or no statistical significant difference in stone clearance.[12] Wei *et al*,[13] carried out lateral PCNL in 347 patients with stone clearance of 82.7% and recommended it to be safe procedure.

In our study population, post-operative complication rate was much lower as compared to what has been reported by other authors. Postoperative fever (101-100 F) was documented only in 4 cases (7.54%), managed with antibiotics. Wei *et al*,[13] reported results similar to our study in individuals undergoing mini PCNL, however Michel *et al*,[14] in their review of complications related to percutaneous nephrolithotomy, reported a much higher rate of complications such as fever in 21-32.1%, rate of transfusion was 11.2-17.5% and major complications such as colonic or pleural injury were 0.2-0.8% and 0.0-3.1% respectively. The rate of transfusion was only 3.77% in our study which was similar to the literature.

Lateral decubitus position was found to be associated with short mean operative time of 55 ± 13.56 minutes, which was comparable to other researchers. Falahatkar *et al*,[15] found mean time to be 99 minutes in prone position and 81 minutes in supine position. The stone-free rate was more than 90% in our study with short operative time. Overall in literature, there is no significant difference between the stone-free rates.[16,17] Table-IV showed the comparison with other studies with comparable patient characteristics.

Table-IV: Comparison of current study with the literature.

Position	Roodneshin *et al*[18]		Gan *et al*[13]	This Study
	Lateral	Prone	Lateral	Lateral
Total no. of patients	26	25	347	53
Mean age	43.5	42.8	48.4	40.3
BMI	39.4	39	40.1	38.8
Operative time	78	91	97	55
Stone size	33	29	24.0	28.0
Hospital stay	2.5	2.8	3 days	1.8
No. of punctures	1.1	1.0	>1 puncture in 19 cases	Single puncture
Rate of stone clearance	89.6%	87.8%	82.7%	96.2%
Access	USG	USG	Fluoroscopy	Fluoroscopy
	2019	2019	2017	2020

Wei *et al*,[13] reported a stone-free rate for patients with non-staghorn stones to be 88.2% while Roodneshin *et al*,[18] reported 89.6% clearance rate. As compared to literature, we had a much shorter operative time and fewer complications. A study performed by Karami *et al*,[19] comparing operative outcomes patients with non-staghorn stone who underwent PCNL in the prone, supine and lateral positions, noted similar success rates 1-month post-procedure in all the positions (92%, 86%, and 88%, respectively).

In the patients with high BMI and severe IHD, there are high risks for developing hemodynamic instability and difficult ventilation in prone position during mini PCNL and with the advent of newer techniques in endourology open surgery seems very unrealistic unless it is the last resort.[20,21] We found lateral decubitus position ideal for PCNL in such patients where cardiopulmonary stress is thought to be poorly tolerated. It is the most convenient position in cases with severe kyphosis, when prone or supine positions are not an option as demonstrated by Gofrit *et al*,[22] and other researchers.[23]

There has been constant struggle to improve the outcomes of percutaneous nephrolithotomy in terms of complications and stone clearance. Microperc has been recently introduced where the PCNL sheath diameter ranges from 12-14 FR as compared to 17-18 FR in mini PCNL.[24] A comparative study revealed microperc to have better stone clearance rate as well as less intraoperative bleeding risk.[25]

There is no ideal position for PCNL, it should be dictated by the patient and surgeon factors, however mini PCNL with fluoroscopy-guided renal access in the lateral decubitus flank position is a safe procedure in high-risk patient where prone position is poorly tolerated.

LIMITATIONS OF STUDY

There were few limitations in our study, the overall follow-up post procedure was relatively shorter. Most patients were lost to follow-up after 4 months, therefore long-term clearance rates were not found. It was not a comparative study, so the ideal position would be dictated by the particular patient circumstances.

CONCLUSION

Minimally invasive percutaneous nephrolithotomy with fluoroscopy-guided renal access in the lateral decubitus flank position, is safe and convenient in high-risk patients where prone position is contraindicated.

Conflict of Interest: None.

Authors' Contribution

SK: Data collection/writing, MN: Article writing, UF: Data Article, KS: Design writing, BM: Proof reading, MK: Proof reading.

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