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# Role of Mini-Percutaneous Nephrolithotomy in the Treatment of Renal Stones

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## Abstract

***Objective:*** *To determine the role of mini-percutaneus nephrolithotomy in the renal stones management and its post-operative complications.*

***Methodology:*** *This descriptive study was conducted at Institute of Kidney Diseases (IKD), Hayatabad Medical Complex, Peshawar from January 2017 to January 2019 over 154 patients. Baseline investigations were carried out for all the patients fulfilling inclusion criteria. All patients provided written, informed consent before the procedure. Demography, operative parameters, and outcomes were analyzed in the study. X-ray KUB was done postoperatively for all patients and follow-up ultrasound examination/NCCT at follow-up visit at 1 month.*

***Results:*** *Out of **154** patients, **90(58.44%)** were male and **64(41.55%)** were female. Mean age of the subjects were **33.3 ± 8.5 (15-70)** years. **84(54.54%)** patients had left renal stones while **70(45.45%)** patients had right renal stones. The mean stone size was **18.52(15–20) mm**. Access to the Pelvicalyceal system was successful in all (100%) cases. The mean operation time was **53.14(45–60)** minutes. The mean hospital stay was **2(2-3) days**. The targeted calyces were upper in **10(6.49%)**, middle in **90(58.44%),** and lower in **54(35.06%)** patients. Complete Stone clearance was achieved in **140(90.90%)** patients while **14(9.09%)** patients had residual stone fragments, out of which **2** patients underwent ureteroscopic fragmentation while **4** patients required post op extracorporeal shock wave lithotripsy (ESWL) for the residual stones. No major complications occurred.*

***Conclusion:*** *Mini- percutaneus nephrolithotomy is an effective minimally invasive modality of treatment in renal stones and is associated with excellent stone clearance, less morbidity and shorter hospital stay*

**Keywords:** *Percutaneous nephrolithotomy, mini-PCNL, Renal stones.*

## Introduction

Humans have been affected by urinary stone disease for centuries. Different treatment options are available for the management of renal stones, depending upon the bulk and location of the stones. The management of stone disease has been changed.The first case of the removal of renal stones by means of nephrostomy by Rupel and Brown[1] in 1941.Percutaneous nephrolithotomy (PCNL) is a minimally invasive surgical modality, was first performed in 1976 by Fernastrom and Johansson, for the management of renal stones.[2,3] In comparison to other management modalilities mini-PCNL has advantage of high stone clearance rate[4].Based on the statistics reported by British Association of Urological Surgeons (BAUS)[5] and Clinical Research Office of the Endourological Society (CROES)[6], risks associated with PCNL consist of postoperative sepsis (2%), fever (10%-16%), and injury to adjacent organs (0.4%). In significant bleeding (8%) are common complications after this procedure , with potentially dangerous consequences.

Keeping in view the recognized risks of hemorrhage and organ injury associated with tract dilation in conventional PCNL, a key strategy is designed at, by reducing the tract size by the miniaturization of equipment/instrument size, as well as the use of laser technology and enhanced optic systems. There has been a dramatic shift in the indications of PCNL

over the last decade. Some studies indicated that by reducing the tract size, complications associated with percutaneous surgery might be reduced[7]. After the introduction of miniaturized instruments including mini-PCNL, ultra mini-PCNL and micro-PCNL, there is no need to dilate the tract over 20 Fr. Jackman et al.[8] first introduced minimally invasive PCNL (mini-PCNL) for pediatric age patients in 1998.

In 2001, a particularly designed miniaturized nephroscope for mini-PCNL in adults was first introduced by Lahme et al.[9] in Germany,after which the procedure of "mini-PCNL" gained popularity rapidly and became more and more admired worldwide. The first generation minimally invasive PCNL (MIP) system had a number of key features which comprise single-stage dilatation of the tract. This also includes additional method of stone clearance by the "vacuum cleaner" effect[10]. Since then, mini-PCNL has gained popularity worldwide.

In 2010 Schilling et al.[11] reported that this practice had completely replaced conventional PCNL in their unit. In terms of improved stone clearance and complications Mini-PCNL is more successful than retrograde intrarenal surgery (RIRS) [12] for patients with solitary kidney having stones with size larger than 2 cm, in patients having congenitally deformed kidneys such as horseshoe kidney, polycystic kidney, and transplanted kidney[13].

The aim of this study is to evaluate the role of mini-PCNL particularly focusing on stone clearance, complications, and retreatment rate.

## Methodology

This was a prospective observational study. Which includes 154 consecutive patients who underwent mini-PCNL from January 2017 to January 2019. The inclusion criteria includes all patients having age 14 years and above, with renal stones having size 15-20 mm in diameter. Subjects with blood dyscrasias ,renal anatomic anomalies and pregnant females are excluded from the study. Detailed history and physical examination was done followed by routine baseline investigations included full blood counts, renal function tests, electrolytes, bleeding parameters, and urine culture. Patient with active urinary tract infection were treated before the procedure with intravenous antibiotics according to C/S report, till urine culture became negative. Stone burden was evaluated using a multi-slice helical computed tomography (CT) scan. All patients were provided written, informed consent before the procedure. Demography, operative parameters, and outcomes were analyzed in the study. All patients had postoperative plain X-ray KUB before discharge from the hospital, and follow-up ultrasound examination/NCCT at follow-up visit at 1 month.

### Surgical Technique

The whole min-PCNL procedure was performed under general anesthesia. Intravenous prophylactic antibiotics were administrated preoperatively. Csytoscopy performed and then 6 Fr open ended ureteral catheter passed into the ureter. Urinary bladder was catheterized with 16 Fr Foley's catheter and the patient was turned prone. The initial puncture was obtained using fluoroscopic guidance by gradual descent technique over the desired calyx with 18-gauge needle and a glide wire was introduced. Initially with use of facial dilator 10F dilatation was performed. Then further dilatation was performed with the single step metal dilator. Stones were broken using a 550 µm holmium stone laser fiber or by ballistic lithotripsy. Stone pieces were removed by the "vacuum cleaner effect". Adherent fragments were extracted with stone grasper. At the end of the procedure, a JJ stent was placed antegradely or the ureteric catheter was left overnight for drainage. Nephrostomy tube was placed in some case while others were tubeless. Once the stone was cleared, the clearance was confirmed with direct nephroscopy and fluoroscopy. If complete stone clearance was not achievable with single access tract, a second access using a 17 F Amplatz sheath was placed under fluoroscopic control. In cases of remaining large fragments, at the end of the procedure, a 12 F nephrostomy tube was placed to allow for a second-look PCNL 7-10 days later.

Postoperatively, all patients were given standard intravenousantibioticsandnarcoticanalgesicsregimen. X-Ray KUB were done on the 1st post-operative day to look for any residual stone in te pelvicalyceal system. In case of no second look procedure, nephrostomy was removed.JJ stents were removed after 2 weeks. Patients were discharged on 1$^{st}$ or 2$^{nd}$ postoperative day. Complication occured intraoperatively or within 30 days were graded by the modified Clavien–Dindo classification system[14] .Stone ≥ 5 mm was considered as clinically significant residual stone fragment (RSF). Stone asymptomatic and size < 5 mm was termed as

clinically insignificant residual stone (CIRF). Complete stone clearance is considered when no residual stone is noted on conventional X-ray. Follow-up of all the patients were carried out at one and three months. Plain X-Ray KUB for radiopaque stones , ultrasound abdomen & pelvis for radiolucent stones , urinalysis and serum creatinine, were performed.

## Results

### Patient and Stone Demographics

In all, 154 patients underwent mini-PCNL.Mean age of the sample was 33.3 ± 8.5 (15-70) years. In all, 84 (54.54%) patients had stones on left-side while 70 (45.45%) patients had right-sided renal stones. The mean stone size was 18.52(15–20) mm. Stones were located in upper calyx in 10(6.49%), middle calyx 30(19.48%), lower calyx in 60 (38.96%), the renal pelvis in 50(32.46%) patients, and upper ureter 4(2.59%). Upper ureteric stones were pushed into renal pelvis during ureteric catheterization.

*Patient and Stone Demographics*

| Variables | Value |
|---|---|
| Number of patients | 154 |
| Gender<br>Male<br>Female | N (%)<br>90(58.44%)<br>64(41.55%) |
| Age | 33.3 ± 8.5 (15-70) years |
| Side<br>Left<br>Right | N (%)<br>84(54.54%)<br>70(45.45%) |
| Stone size, mm | 18.52(15–20) mm |
| Access to pelvicalyceal system<br>Upper-calyx<br>Middle-calyx<br>Lower-calyx<br>Renal-pelvis<br>Upper-ureter | N (%)<br>10(06.49%)<br>30(19.48%)<br>60(38.96%)<br>50(32.46%)<br>04(02.59%) |

### Access and Instruments

In all, 154(100%) mini-PCNL cases were performed. Access to pelvicalyceal system was achieved through a single puncture in 130 (84.41%) cases, while in 24(15.58%) patients with double puncture. Lower calyceal approach in 54 (35.06%) cases, middle calyx 90 (58.44%), and upper calyx 10(6.49%). Mini PCNL access sheath of 17.5 F was used in all cases. Glide wire were used in all cases during initial puncture.

*Access and Instruments*

| | |
|---|---|
| Position<br>Prone<br>Supine | <br>154(100%)<br>0 |
| Punctures<br>Single<br>Double | <br>130(84.41%)<br>24(15.58%) |
| Access<br>Upper calyx<br>Middle calyx<br>Lower calyx | <br>10(06.49%)<br>90(58.44%)<br>54(35.06%) |
| Access sheath | 17.5F |

### Fragmentation and Stones Removal

The lithoclast used was pneumatic to break stones in 110 (71.42%) cases and a holmium laser in 44 (28.57%) cases. Stone fragments were retrieved using forced irrigation from ureteric catheter in 104(67.53%) cases and graspers in 50(32.46%) cases. The mean duration for procedure was 53.14(45–60) min. The operative duration was related to stone burden. 140(90.90%) patients had Complete stone clearance while 14(9.09%) patients had residual stones. Out of which 2 patient required ureterorenoscopic stone fragmentation (URS) and 4 patients required post-operative ESWL while in the rest 8 patients stone fragments were so small that they passed spontaneously during the follow up. Post operatively drainage was provided in the form of a nephrostomy tube and JJ stent in 44(28.57%) cases while in 100(64.93%) cases tubeless procedures (only JJ stent) were perfumed. In 10(6.49%) cases were total tubeless procedures were performed. The mean inpatient stay was 2 (2–3) days.

*Operative Details*

| Fragmentation: | N (%) |
|---|---|
| Pneumatic lithoclast | 110(71.42%) |
| Holmium laser | 44(28.57%) |
| Stone extractors: | |
| Forced irrigation | 104(67.53%) |
| Gracepers | 50(32.46%) |
| Operative time | 53.14(45–60) min. |
| Stone clearance rate: | |
| Complete | 140(90.90%) |
| Residual fragments | 14(09.09%) |
| Drainage: | |
| Nephrostomy+JJ | 44(28.57%) |
| Tubeless (only JJ) | 100(64.93%) |
| Total tubeless | 10(6.49%) |
| Hospital stay | 2(2-3 )days |

## Complications

Complications were classified according to Clavien Dindo classification. No serious complications were seen during the study. Complications occurred in 39(25.32%) cases. Of them 19(12.33%) were Clavien **Grade 1,** 11(7.14%) were Clavien **Grade 2**, and 9(5.84%) were **Grade 3** (5.84%). There were no **Grade 4 or 5** complications.

**Grade 1** complications like, Transient fever (more than 38°C) in 14 (9.09%) and transient elevation of creatinine occurred in 5(3.29%) patients which responded to the usual treatment.

**Grade 2** complications, perinephrostomy leakage 6 (3.89%) patients, blood transfusion in 2(1.2%) patients and pneumonia occurred in 3(1.94%) patients, which responded to usual treatment.

**Grade 3** complication, like urinary leakage occurred in 3 (1.94%) patients which were managed with JJ stent placement. 2 patients required URS and 4 patients required post-operative ESWL for residual stones.

| Complications | N (%) |
|---|---|
| Yes | 039(25.32) |
| No | 115(74.67) |
| Grade -1 complications | 19 (12.33%) |
| Grade -2 complications | 11 (07.14%) |
| Grade -3 complications | 09 (5.84%) |
| Grade -4 complications | 00 (00) |
| Grade -5 complications | 00 (00) |

## Discussion

Percutaneous nephrolithotomy is recommended nowdays as procedure of choice for stones measuring >2cm in diameter with high stone free rate. [15] Due to its high safety and efficacy it os highly demanding procedure nowdays.[16]. in Standard PCNL access to the pelvicalyceal system is carried out by using amplatz sheath of 24-30 F while mini-PCNL is performed by using amplatz sheath upto 18F with less bleeding compication[17,18]. Further, to decrease the morbidity and mortiliy of this procedure, minimally invasive techniques are established. Amplatz sheath of 18 Fr, one step dilator and low prsssure irrigation is used. Stone fragments are retrieved without any use of forcep.

Although mini-PCNL results in complete stone free rate in 92.9% of patients with kidney stone of <2 cm[19]. However,it also give good results in patients with a larger stone size. Limitations may be the conversion of mini-PCNL to conventional PCNL where required.

In the present study, we have achieved excellent stone clearance rate of 90.90%, which is comparable to internationally reported outcomes of mini-PCNL. These results are supported by Li et al.[20] who had stone free rate in his study 89% for his 4760 mini-PCNL. Similarly, Zeng et al.[21] had 90%(146) stone free rate for his super mini percutaneous nephrolithelopexy. While Abdelhafez et al.[22] and Agrawal et al.[23] had 84%(191) and 99%(120) stone free rates. Our results are consistent with international studies in terms of stone clearance.

Jackman et al.[17] reported, SFR of 89% with mean hospital stay of 1.7 days.They concluded that mini-PCNL may be benifical in comparison to conventional PCNL for per-op bleedings risk , post-op hospital stay, and postoperative analgesia, which confirms our present results.

Operative time for our study was 53.14(45–60) min and blood transfusion in 2(1.2%) patients**.** Yang et al.[24] reported Stone free rate of 97.2% with mean operative time of 45 min for patients with proximal ureteric stones. Decreased transfusion rate in mini-PCNL may be due to less trauma to parenchyma and large segmental vessels by suing small bore amplatz sheath. The decreased operative time might be due to “vacuum cleaner effect” in which stone fragments are retrieved without using forcep. Retrieval of small fragments occurs when turbulence flow occurs at the tip of sheath with fragments finding low pressure area to escape. The process of fragmentation in mini-CNL can be done with laser and ballistic lithotripsy. High-frequency and low-energy ‘dust’ settings are preferable[25]**.** In our procedure ,stne fragmentation was done with pneumatic lithoclast and holmium laser.

The fragmentation of stone with the mini PCNL is possible with ballistic lithotripsy and laser. We used both pneumatic lithoclast and holmium laser for stone fragmentation.

According to British Association of Urological Surgeons (BAUS) PCNL registry and CROES PCNL registry, overall complication rate was 21.3% and it was 20.5% respectively[5,26]. Our complications rate was consistent with international studies and were primarily low grade in nature. No Clavien IV/V complications were recorded.

## Conclusion

Mini-PCNL is an effective minimal invasive management modality in renal stones and is associated with excellent stone clearance, less morbidity and shorter hospital stays.

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