

Original Research Article

Mini percutaneous nephrolithotomy: its role in the management of renal stone and our tertiary care centre experience

Avinash Pratap Singh Thakur^{1*}, Darsan S.²

¹Department of Urology, Super specialty Hospital, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh, India

²Department of Urology, Super speciality block, Government Medical College, Thiruvananthapuram, Kerala, India

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*Correspondence:

Dr. Avinash Pratap Singh Thakur,
E-mail: drapst@gmail.com

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ABSTRACT

Background: Miniaturized percutaneous nephrolithotomy (PCNL) procedures for urolithiasis have gained increased popularity in recent years. To decrease the complications of conventional PCNL by reduced tract size led to the development of Mini PCNL, which makes the use of 15-18F sheaths in place of 24-30F of conventional PCNL. It has developed rapidly and become a popular technique of renal stone management with reduced morbidity and excellent outcome. Authors report our experience with Mini PCNL for the treatment of renal stone.

Methods: In between his August 2015 and January 2018, sixty patients with the diagnosis of unilateral single medium size (8-20mm) renal stone were identified. Patient's demographical, clinical, diagnostic and procedural data were recorded. All patients were evaluated by history taking, physical examination and laboratory investigations. Radiological evaluation was done with X ray kidney, ureter and bladder region (KUB) and also with renal ultrasonography followed by computed tomography (CT). All patients underwent Mini PCNL using 12F nephroscope and 16.5/17.5F sheath. Holmium: YAG laser was used for stone fragmentation. No nephrostomy tube was used routinely. Treatment outcome was assessed in terms of operative time, haemoglobin drop, hospital stay and stone free rate.

Results: Complete stone fragmentation was achieved in 41 out of 60 patients using Mini PCNL, so initial stone free rate was 68.3%. After 4 weeks of surgery total 53 patients were stone free (88.3%), 5 patients required some auxiliary procedure for complete clearance of stone and other 2 were managed conservatively. The mean operative time was 48.28 min, mean haemoglobin drop was 0.74gm/l and mean postoperative hospital stay was 54.22 hours. After 12 weeks postoperatively all patients were stone free. There were no significant postoperative complications, and all had good quality of life.

Conclusion: Mini PCNL technique appears to be safe and effective alternative to conventional PCNL for moderate size renal calculi. It is usually related to less blood loss and shorter hospital stay than the standard method. It can achieve good stone-free rates with minimal complications and low morbidity. Mini PCNL can also be considered as a good alternative to retrograde intrarenal surgery and shockwave lithotripsy in selected cases. However, further high quality studies with larger sample size are required in future.

Keywords: Mini-percutaneous nephrolithotomy, Mini- Miniaturized percutaneous nephrolithotomy, Renal stones, Stone-free rate

INTRODUCTION

Renal calculi disease is a common urological problem which affects all age group and characterized by high

recurrence rate.¹ Nephrolithiasis management has undergone drastic transformation since 1980s following the introduction of extracorporeal shock wave lithotripsy (SWL) and endourological procedures such as ureterorenoscopy (URS), percutaneous nephrolithotomy (PCNL), and retrograde intrarenal surgery (RIRS).² The debate is continuing on all these modalities that which one is the best. In procedure selection for every patient there should be a clear balance in between the efficacy, safety, and complications associated with that particular selected technique.

PCNL is an effective technique that achieves high stone-free rate and shorter overall treatment time.³⁻⁵ Major drawback of PCNL is its relatively higher morbidity, like bleeding and trauma. To decrease these complications by reduced tract size led to the development of Mini PCNL and other minimally-invasive percutaneous approaches (Minimally-invasive PCNL).^{6,7} Mini-PCNL uses 12-14F size nephroscope with 15-18F Amplatz sheath, in place of 24-30F sized sheath of conventional PCNL, in order to reduce the morbidity of the procedure.⁸

Mini-PCNL was introduced by Helal et al, who performed it on a 2-year-old child with the use of smaller access diameters instruments in 1997 and then Jackman et al. further developed it, to be a treatment option for adults.^{9,10} As compare to the standard PCNL, mini-PCNL uses the tract of <20 Fr with less morbidity and similar stone free rates.^{11,12}

Since then, mini-PCNL has developed widely worldwide and become a popular technique of renal stone management with reduced morbidity and excellent outcome. The objective of this study is to present our experience with 60 cases of Mini PCNL who underwent this procedure for moderate size renal calculi (8 -20 mm) at our tertiary care centre.

METHODS

This study was a prospective study. It was conducted between August 2015 and January 2018, sixty patients with the diagnosis of renal calculi underwent Mini PCNL at our institution.

Inclusion criteria

All patients of renal calculi having:

- Moderate size single renal calculi of size between 8-20 mm
- No active urinary tract infection (UTI)
- No coagulation disorders

Exclusion criteria

- Stag horn renal calculi
- Pregnant women
- Untreated urinary tract infection
- Anomalous kidney with stone

Patient's demographical, clinical, diagnostic and procedural data were recorded. All patients were evaluated by history taking and laboratory investigations including complete blood count, fasting blood sugar, kidney and liver functions, urine analysis and culture, bleeding profile. Radiological evaluation was done with X ray KUB region and renal ultrasonography followed by computed tomography (CT). Patients with positive urine culture were treated by antibiotics before surgery.

Full written informed consent was obtained from each patient after explanation of all the available techniques. Stone size was calculated on CT scan preoperatively.

Surgical technique

All 60 patients underwent Mini-PCNL in the prone position under general anaesthesia. Initially in lithotomy position 6 Fr (French) ureteric catheter was inserted by cystoscopy up to pelvicalyceal system then patient turned into prone position. Desired calyx and proper puncture site were selected with the help of contrast injection using bulls eye method under fluoroscopic guidance. A 20-G initial puncture needle was used for calyceal puncture. J-tipped guide wire of size 0.035 was inserted through the puncture needle into the renal pelvis. Dilatation of the tract was performed by using single step dilator. After tract dilatation, 16.5/17.5 Fr operating sheath was inserted. A rigid 12-F nephroscope was introduced and stone fragmentation was done using a Ho: YAG laser (365 µm fibre, energy 0.8 J, frequency 12 Hz). At the end of the procedure a 16-Fr urethral catheter was left in situ for 48 hours with the ureteric catheter and without any nephrostomy tube.

Perioperative management was carried out, third generation cephalosporin was used as prophylactic antibiotics. On third postoperative day if no urinary leakage was observed at the site of surgery, ureteric catheter was removed.

Study parameters included were perioperative outcomes like mean operative time, stone size, haemoglobin level drop, need of blood transfusion, incidence of post-operative fever, post-operative hospital stay and need of auxiliary procedure like ESWL (Extracorporeal shockwave lithotripsy) for residual fragments. Success rate was defined as absent of residual fragment or residual fragments less than 3 mm on follow up imaging. Patients were followed up after 4 weeks and 12 weeks of surgery by clinical and radiological evaluation. All variables were categorical, and percentage and proportions were calculated manually.

RESULTS

Patient's characteristics with stone parameters are recorded and listed in Table 1. Baseline demographics included are patient's age, sex ratio, body mass index,

size and location of stone, comorbidities, and recurrent stone disease (Table 1).

Table 1: Clinical data of patients in Mini PCNL.

Variable	All patients (total N=60)
Age in years (mean, range)	36.4(19-62)
Male and female (ratio)	42/18
Body mass index in kg/m ² (mean, range)	24.2(19.6-30.2)
Stone size in mm (mean, range)	14.4 (8 -20)
Right and left	32/28
Stone location - Pelvic	20
Lower calyx	18
Middle calyx	14
Upper calyx	08
Recurrent stone formers	12
Comorbidities - Diabetes	08
Hypertension heart disease	14
Renal insufficiency	06

Mean age of the patient was 36.4 years, out of 60 patients 42 were male and 18 were female. Mean stone size was 14.4 mm and involvement of right and left kidney was 32 and 28 respectively. Total 12 patients were recurrent stone formers. Single tract was used for all patients' procedure. In 52 patients, access was obtained via an infra-costal puncture; while in the remaining 8 patients, access was achieved via a supra-costal puncture (11th inter-costal space). (Table 1)

Perioperative and postoperative variables are listed in Table 2.

Table 2: Perioperative and post-operative data.

Factor	All patients (N =60)
Operation time (mean, range)	48.28 min (28.30-68.42)
Stone fragmentation time (mean, range)	34.22 min (22.34-52.5)
Haemoglobin drop (gram/l)	0.74 (0.34-1.4)
Fever	08/60
Post-operative hospital stays (in hours)	58.22 (46.0-96.2)
Stone free rate(SFR) - Initial	68.33% (41/60)
Later (after 4 weeks)	88.33% (53/60)
Auxiliary procedures	5/60
Stein Strasse	4/60
Urine leakage	2/60
Recovery time	6.4 days (5- 12)

The mean operation time (defined from initial puncture to sheath removal) was 48.28 minutes while the stone fragmentation time was 34.22 minutes. Haemoglobin

drop was not very much and none of the patient required blood transfusion. Complete fragmentation of stone was achieved in 41 out of 60 (68.33%) patients. In the postoperative period fever was seen in 8 patients (13.33%) who were responded with step up antibiotics, there was no episode of urosepsis. (Table 2)

The mean postoperative hospital stay was 58.22 hours. Kidney function was stable for all patients. Out of 60 patients 5 patients required ancillary procedures, 3 patients were treated by extracorporeal shock wave lithotripsy (ESWL) and 2 out of 4 patients who developed steinstrasse with urine leakage were managed by ureterolithotripsy while remaining 2 patients of steinstrasse without any urine leakage were managed conservatively.

All patients were discharged from the hospital on postoperative day 2; mean hospital stay was 58.2 hour (range 46.0 - 96.2).The initial SFR (measured by X ray KUB on 2nd post-operative day) was 68.33%, then after the 4 weeks the SFR increased to 88.33% (measured by x ray KUB and ultrasonography). Finally, after auxiliary procedures in some patients, all became stone free at 3 months follow-up. In any patient there were no long-term complications up to the 3-month follow-up visit (Table 2).

DISCUSSION

PCNL has become the standard treatment nowadays with which all other techniques should be compared. The main concern of PCNL is the risk of complications such as trauma and uncontrollable bleeding. From last three decades, PCNL has undergone several changes with resultant reduced morbidity and higher success rate. There are continuous improvements in techniques and instruments of PCNL with high levels of safety and efficacy. However, haemorrhage and postoperative pain are still common concern for all types of PCNL.

From the conventional PCNL in which Amplatz sheaths of 24-30F used, the Mini PCNL differs, it uses 15 -18F sheaths with resultant advantages of reduced tract size, less trauma and less bleeding. In addition, most lithotripters can be used through the PCN tunnel to fragment the stones.

After its introduction by Jackman et al, the efficacy and safety of Mini-PCNL has been very well established in decreasing the morbidity as compared to conventional PCNL.^{9,10,13}

Renal parenchymal injury are lesser in the Mini PCNL as compared to conventional PCNL without any effect on working access. One key factor for blood loss during PCNL surgery is the size of the tract, so mini-PCNL with smaller tract can reduce the bleeding and subsequent blood transfusion compared to conventional PCNL.^{6,14}

Mini PCNL has proven to be a safe and effective procedure, with reduced pain, decreased time of hospital stay, and lesser complications.¹⁵⁻¹⁷ Analgesic requirement is also less in mini-PCNL as compared to standard PCNL.⁷

Mini PCNL is safe and feasible in moderate volume renal calculi disease with less complication rate and high stone free rate. Its indication are small and moderate sized calculi, preferably size less than 20 mm, it can be used as an alternative to retrograde intra renal surgery(RIRS) or shock wave lithotripsy (SWL), it is also useful in lower pole calculi which are not amenable to RIRS, stones refractory to SWL and diverticular renal stones.¹⁸

Mini-PCNL carries high efficiency rate in relation to SFR, retreatment, and requiring fewer auxiliary procedures, it has a significant advantage in SFR in all location of kidney. Mini PCNL shows better SFR than ESWL especially for stones >10 mm.^{19,20} Even for stone of size 20- 30 mm it is having better SFR than RIRS.²¹

As compare to RIRS the Mini PCNL is less expensive, which is also a factor in favour of this procedure, because cost is also important in selection of procedure especially in developing world.²² Complication rates are not significantly different between Mini PCNL and RIRS.²³ There is some concern regarding renal parenchymal damage by Mini PCNL but there are studies reported that kidney damage from PCNL tracts is negligible.²⁴

Lee et al. reported a study to compare RIRS and mini-PCNL for management of patients with renal calculi of >1.0 cm and found that both techniques are equally effective and safe, with a SFR of 85.7%% in the mini-PCNL group after a single session at 12 weeks follow-up.²⁵ Regarding mini-PCNL even in the first series, the SFR was high enough. Jackman *et al.* reported an SFR of 89% in adults and 85% in children with a stone burden 1.5 cm² and 1.2 cm², respectively.^{10,26}

Our present SFR (88.3%) for Mini PCNL is also similar to that reported by Lee et al . It is lesser than reported by Yuruk et al (96.7%), but much better than that reported by Kuo et al (66.7%).^{27,28}

There is on-going debate on the effectiveness of mini-PCNL. Proponents of the method include increased manoeuvrability, limited blood loss, and decreased postoperative pain with limited hospital stay.

Limitations of the procedure mention the necessity to fragment stones into small enough to fit through a smaller-size sheath which results in longer operative times. It is mainly concerned with the stone size larger than 2 cm, because the time taken to fragment and clear the particles through 15-18F sheaths is higher as compare to standard PCNL. Despite all this, operative time is closely related with the surgical techniques and surgeon's experience, different surgeons from different centres provided a large variation in operative time.

Some specific situation like; larger stone burden, branched or multiple calculi, especially in a dilated pelvicaliceal system, Mini PCNL is unlikely to be better than standard PCNL. Thus, this technique appears to be more suitable for the management of low-volume renal stone.

Stone fragments smaller than 3 mm are usually considered as Clinical insignificant residual fragments (CIRFs) although it is believed that if CIRFs are left untreated, a stone-related event occur in approximately half of the patients, for which more than 50% will also require further intervention.²⁹ Most authors use plain X-ray of KUB or ultrasonography for follow up. Computed tomography (CT) and Nephrography are used less commonly.^{20,30}

Recently concept of tubeless PCNL has come in selected cases of renal stone which is associated with less postoperative pain also.³¹

Diabetes mellitus and female gender are the risk factors for sepsis following mini-PCNL.³² Probability to require longer hospitalization time is higher in patients with large stone burden, diabetes, impaired renal function and UTI.³³ Body mass index does not seem to correlate with higher complication rates.

The surgical technique for the treatment of the renal calculi should be individualized for every patient. The patient related factors, stone related factors and anatomical features are primarily important in the procedure selection process.

Most of the patients in our study who underwent operation with Mini PCNL had good postoperative outcomes. Our study has some limitations. First, this study is not a nonrandomized study, second it is undertaken at a single centre with a limited number of patients so the potential selection bias cannot be eliminated. The results need to be validated by randomized prospective trials in future. However, the study results indicate excellent stone clearance without significant morbidity.

CONCLUSION

While standard PCNL remain the benchmark surgical intervention for upper tract urolithiasis, the potential role for Mini PCNL is emerging. Mini-PCNL seems to be safe and effective treatment for patients with a medium sized stone in particular less than 20 mm. It is related to higher stone-free rate, less blood loss, shorter hospitalization and fewer complications. Although it is very promising, further well-designed, randomized studies are needed, before considering it as a standard procedure in the management of renal stone.

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