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Research Article

EFFICACY AND SAFETY OF ULTRA-MINI PCNL FOR RENAL STONES < 2cm—A Prospective Observational Study

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ABSTRACT

Background: Nephrolithiasis is a global problem in the general population due to its high prevalence and frequency of recurrence. The incidence of renal stones is 6% in women and 12% in men. Management of renal stones has undergone a complete transformation since 1980, following the introduction of ESWL and endourological procedures like PCNL, URS, and RIRS. PCNL has established itself as an effective and safe treatment option with a high stone-free rate and shorter overall treatment time. UM-PCNL, the latest advancement, is an attempt to reduce the tract size further.

Objectives: To assess the safety and efficacy of ultra-mini PCNL.

Methods: Patients with a kidney stone size less than 2cm who preferred to undergo ultramini PCNL were included in the study. The following observations were recorded: Size of stone(mm); Location of stone; Laterality; Operative time; Post-operative complications; Hospital stay (days); Post-operative stenting; Stone-free rate.

Results: In our study, patients aged between 11-70 years were enrolled. The most common presenting complaints were flank pain and haematuria. Patients had a stone size documented in the range of 10-20mm, with the majority of them on the right side. The mean operative time was 65.98±13.24 minutes. Conversion to mini PCNL was seen in 3(9.09%) patients. Postoperative complications like fever were seen in 3(9.09%) patients. The majority of patients, 27, were hospitalised for 1-2 days. Complete stone-free clearance was achieved in 31 (93.94%) patients, while residual fragments were found in two patients after four weeks postoperatively by radiological evidence.

Conclusion: Ultra-mini PCNL is safe and effective in achieving a higher stone-free rate characterised by less blood loss, shorter hospital stay, less postoperative pain, less invasive, so minimal scar marks and minimal morbidity.

Keywords*: Ultra-mini PCNL (UM-PCNL); Renal stones; Stone-free rate; Minimally invasive surgery.*

INTRODUCTION

Nephrolithiasis is a global problem in the general population due \\to its high prevalence and frequency of recurrence. The incidence of renal stones is 6% in women and 12% in men[1]. Urolithiasis is a common urological problem in India, including the Kashmir Valley, as well and is correlated with nutritional and genetic factors. This growing trend is believed to be associated with changes in lifestyle modifications such as lack of physical activity and dietary habits[1–3]. The pathogenesis of kidney stones is a complex biochemical process which remains incompletely understood [3].

The main symptom of Nephrolithiasis is intermittent flank pain accompanied by haematuria, nausea and vomiting[4]. Untreated renal stones can lead to obstruction with subsequent urinary tract infection, which may lead to urosepsis and death. Persistent urinary tract obstruction may result in renal insufficiency and end-stage renal disease[5,6]. Long-term complications include recurrent pyelonephritis and loss of renal function[7].

Management of renal stones has undergone a complete transformation since 1980, following the introduction of ESWL and endourological procedures like PCNL, URS, and RIRS[8,9]. PCNL has established itself as an effective and safe treatment option with a high stone-free rate and shorter overall treatment time [10–12]. However, the biggest limitation of PCNL is its relatively higher morbidity, including trauma and bleeding. With growing evidence, it has been found that a reduced tract size leads to a reduction in morbidity from PCNL[11–14]**.** Recent developments in PCNL have been targeted towards creating a reduced tract size to reduce complications. This advancement has led to various minimally invasive percutaneous approaches, including S-PCNL, mini-PCNL, ULTRA-MINI PCNL and MICRO-PCNL[15].

In S--PCNL, a 20-30fr amplatz sheath is used for making the tract. It is indicated in larger stones, especially in stag horn calculus. Energy sources used are pneumatic, ultrasound or laser. However, the limitation is that due to increased tract size and multiple tracts, complications are more including bleeding, and the need for blood transfusion is in 3-6%. In MINI-PCNL, a 15-20fr Amplatz sheath is used for making a tract compared to the 20-30 Fr-sized sheath used in S-PCNL. It is used in a complex stone burden. It has a high stone-free rate. Energy sources used for fragmentation are pneumatic, ultrasound or laser. The limitation of this technique is that it takes a longer operative time for larger stones, comparable to S-PCNL.

In MICRO-PERC, a 4.85fr "all-seeing" needle is used. However, as Micro-Perc does not even make use of the working sheath and does not employ an Amplatz sheath, so irrigation fluid does not have an outlet, and neither can stone fragments and debris be cleared during the procedure, as in conventional PCNL.

UM-PCNL, the latest advancement, as the name suggests, is an attempt to reduce the tract size further. UMPCNL uses a 1mm (3fr) telescope with a specially designed 7.5fr nephroscope to carry out the procedure with an 11-13fr-sized sheath. The reduction in the tract size from 30fr to 11fr ultimately reduces cross-sectional surface area to nearly one-eighth of the original tract size compared to S-PCNL. This significant reduction in the procedure's invasiveness reduces complications, morbidity, hospital stay, postoperative bleeding, the need for blood transfusions, and minimal scar marks. In the UMPCNL technique, stone fragments are washed out using the "water jet'' effect using saline irrigation. There is also spontaneous expulsion of stone fragments through the sheath under the influence of turbulence produced by irrigation fluid as they are broken up. There is no need for graspers or baskets for stone retrieval, which is opposite to S-PCNL, where each fragment needs to be extracted manually. One added advantage of UMPCNL is that it can be a "total tubeless procedure" (no nephrostomy, no stent), leaving only a catheter in place in most patients. UMPCNL provides a higher stone-free status in terms of both on-table stone clearance and long-term stone-free rate. In our study, we evaluated the safety and efficacy of UMPCNL and reported our outcome.

Material and Methods:

After obtaining ethical clearance from the Institutional Ethical Committee, the present observational study was conducted in the Postgraduate Department of General Surgery, Government Medical College, Srinagar, over a period of two years. After obtaining the proper informed consent in the local language, patients with a kidney stone size less than 2cm who preferred to undergo ultra-mini PCNL were included in the study.

A consecutive sample of 33 patients fulfilling inclusion and exclusion criteria underwent UMPCNL performed by a single Urologist were observed during the study period. The following observations were recorded: Size of stone (mm); Location of stone; Laterality; Operative time; Post-operative complications; Hospital stay(days); Postoperative stenting; Stone free rate.

SURGICAL TECHNIQUE

With the patient under general anaesthesia, positioned in a lithotomy position, retrograde ureteric catheterisation is done by a 5fr open-ended ureteric catheter via cystoscope. The patient is catheterised with a two-way Foley catheter. The ureteric catheter is fixed to the indwelling catheter. The patient is repositioned into the prone position. A contrast pyelogram is done under C-arm guidance, and the appropriate calyx is chosen for puncture. Fluoroscopy-guided percutaneous puncture is made by an 18-G two-part trocar needle into the desired calyx by the Bull's eye or Triangulation technique. After the fluid efflux is seen or urine is aspirated, normal saline is injected into the collecting system through the ureteric catheter to confirm the puncture. Then 0.035" Guide wire (hydrophilic nitinol) is inserted into the renal collecting system through the puncture needle, which is then withdrawn. The tract is dilated with the help of fascial dilators (up to 14Fr) over the guidewire. 0.035" guidewire is replaced by 0.018" guidewire. Then 11-13 fr metallic working sheath is advanced over a 0.018" Guidewire to the appropriate location in the desired calyx. Subsequently, a 7.5 fr nephroscope is inserted into the collecting system through the working metallic sheath. Calculus, once identified, is ablated by Holmium: YAG Laser using 230µm laser fibre.

Various laser settings used are as follows: Fragmentation (1 J x 8 Hz), Dusting (0.6 J x 15 Hz) & Popcorn (1.2 J x 15 Hz). Following fragmentation, the fragments are retrieved by pressure irrigation. At the end of the procedure collecting system is assessed by a UMP nephroscope combined with fluoroscopy for potential residual fragments. This is followed by the placement of DJ stent (5 Fr / 26 cm). An indwelling urinary catheter is left in place, and the procedure is completed. (Figure 1 -11).

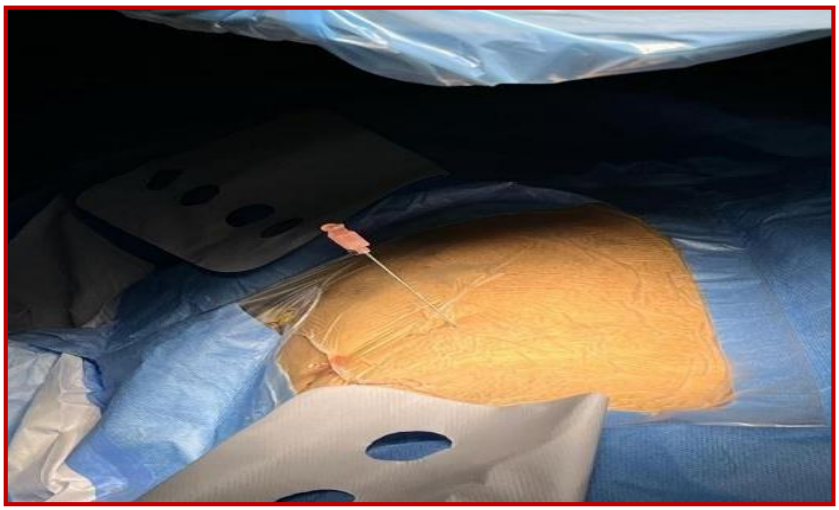

Figure 1: Puncture with 18 G Needle

Figure 2: Placing Guidewire 0.035''

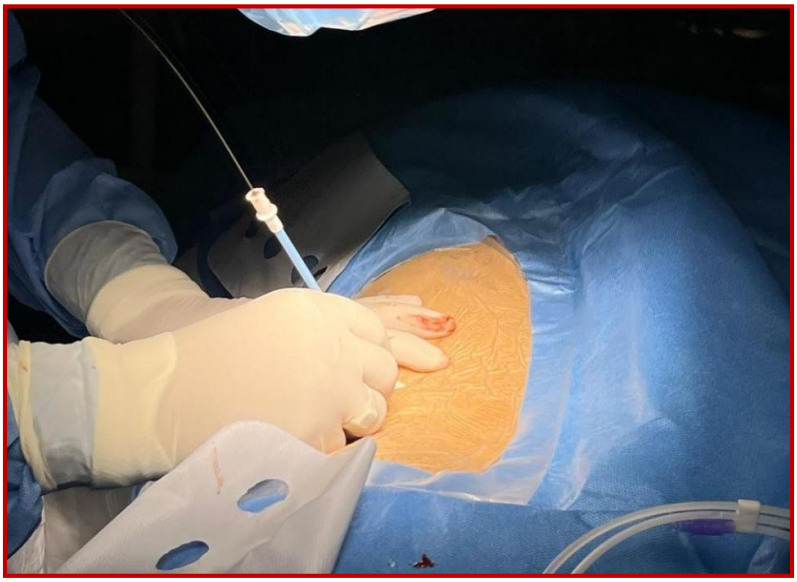

Figure 3: Dilation of Tract

Figure 4: C-Arm View

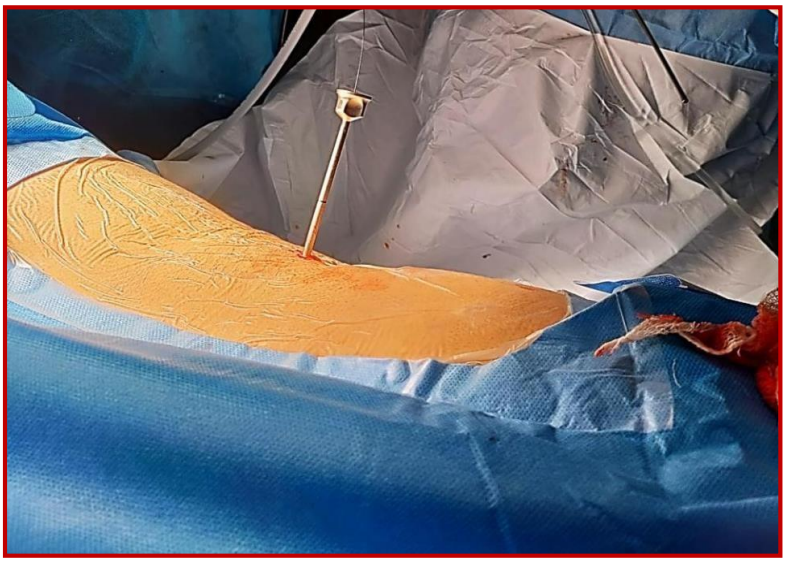

Figure 5: Placing the mini sheath over 0.018'' Guidewire

Figure 6: C-Arm View of Sheath

Figure 7: Final Picture

Figure 8: Stone Clearance Picture

Figure 9: Post-Operative X-Ray KUB showing left DJ Stent in situ.

POSTOPERATIVE CARE

Patients were encouraged to ambulate on the same day. X-ray KUB was done within 24 hrs. Pain management was done with analgesics. Foley's catheter was removed the following day. Patients were followed-up after: (a) 1 week - for complications like fever, pyelonephritis, sepsis, (b) 6 weeks – NCCT KUB Region, (c) 6 months – Trans abdominal USG.

RESULTS:

In our study, patients were enrolled in the age group of 11-70 years with a mean age of 34 ±15.02 years. The majority of patients were males, 22 (67%), and females, 11(33%). The most common presenting complaint was flank pain, haematuria, nausea and vomiting. Comorbidities like hypertension were seen in 12.2% of patients, 9.09% of patients had diabetes, and 9.09% had hypothyroidism. Patients had a stone size documented in the range of 10-20mm, with the majority (51.51%) of them having in between 10-15 mm, 39.4% in the range of 15- 20 mm, and 9.09% with a stone size ≤10 mm. The mean stone size in our study was 14.01±3.13. 54.54% of patients had stones on the right side, while 45.46% were on the left. None of our patients had any significant blood loss or needed any blood transfusion. Most of the patients had stones in the inferior calyx 14 (42.42%) patients, 9 (27.28%) patients had stones in the renal pelvis, 5 (15.15%) patients had stones in the middle calyx, 4(12.12%) patients had stones in PUJ, and only 1(3.03%) patients had a stone in the superior calyx. The majority of patients were operated on within 30-90 minutes. The mean operative time was 65.98±13.24 minutes. Conversion to mini PCNL was seen in 3(9.09%) patients. Postoperative complications like fever were seen in 3(9.09%) patients. The majority of patients, that's 27 (81.82%), were hospitalised for 1-2 days, 5 (15.15%) for 2-3 days and only 1 (3.03%) patient was hospitalised for 3-4 days. Postoperative stenting was done in 31(93.94%) patients. Complete stone-free clearance was achieved in 31 (93.94%) patients, while residual fragments were found in two patients after four weeks postoperatively by radiological evidence.

DISCUSSION:

In our study, patients aged between 11-70 years were enrolled in which majority belonged to the 30-40 years age group (45.46%), 8(24.24%) patients aged <30 years, 4 (12.12%) patients aged 50-60 years, four patients (12.12%) patients aged between 60-70 years while as only two patients(6.06%) were between the 40-50 years. The mean age in our study was 34 ±15.02 (11-70) years. Our study results are comparable with the findings of Desai et al. (2013), where the mean age was 48.2 years (2-70 years). He conducted a study from April 2012 to July 2012 on a novel technique of UMPCNL for stone sizes less than 2cm. The study was performed on 36 patients by one of the two experienced surgeons (G. Zeng and J. Desai). The study's primary aim was to introduce the UMP technique (including equipment required, renal access method, number of punctures needed, tract dilation method, stone fragmentation, and extraction method) and to report the outcome of UMP in this group of patients.[16]. 4 (12.12%) patients were hypertensive, 3(9.09%) patients were Diabetic, and 3(9.09%) patients had hypothyroidism. Most patients were males; 22 (67%) and 11(33%) were females. Our results are comparable with Haghighi et al. (2017), whose study contained 23(65.7%) males and 12(34.3%) females.[17]

The mean stone size was 14.01 ± 3.13 with a range of (6-20) mm, and most of the stones were on the right side in 18(54.54%) patients. Our results are comparable to Haghighi et al. (2017), whose mean stone size was 14.2 mm. He conducted a study on UMPCNL to assess the effectiveness and advantages of UMPCNL vs S-PCNL, as one of the most important differences between the various pcnl techniques is the size of renal access[17]. 14 (42.42%) patients had stones in the inferior calyx, 9(27.28%) patients had stones in the renal pelvis, 5(15.15%) patients had stones in the middle calyx, 4 (12.12%) patients had stones in PUJ, and 1(3.03%) patient was having a stone in the superior calyx. Our study results were in conformity with Agarwal et al. (2016), where the stone location was in the renal pelvis (30%), lower calyx (32.5%), middle calyx (15%) and upper calyx (10%) and upper ureter (12.5%)[14].

In our study, only 3 (9.09%) patients were converted to mini PCNL. Our results are comparable to Agarwal et al. (2016), who conducted a study on UMPCNL-A minimally invasive option for stone removal. In his study, out of 120 patients, six patients were converted to M-PCNL[14].

The mean operative time for complete stone fragmentation using laser was 65 ±13.24 (3090) minutes. Our studies are comparable with J Desai et al. (2013). The mean operative time in his study was 59.8 ±15.9 (30- 90 minutes)[16].

In our study, only 3 (9.09%) patients developed a postoperative fever that resolved within one day with IV antibiotics, while no patient developed Sepsis or Pyelonephritis. Our study results were comparable with the results of Desai et al. 2013 where Postoperative fever occurred in 3(8.3%) patients, urinary extravasations in 1(2.8%) patient and sepsis in 2(5.8%) patients[18].

The Mean hospital stay in our study group in days was 1.71 ± 0.46 (1-4) days. Similarly, the mean hospital stay in days was 3 (2-5) days, as seen in a study done by Desai et al. (2013)[18]. Postoperative stenting was not done in 2(6.06%) patients, while 31 (93.94%) patients were stented postoperatively, which were removed after six weeks of the procedure. Our study was comparable with Mishra et al. (2022), where postoperative stenting was done in 30% of patients[19]. Complete stone-free status was achieved in 31 (93.94%) patients, while residual fragments were found in two patients after four weeks postoperatively by radiographic evidence. Our study results are in comparison with Desai et al. (2013) and Agarwal et al. (2017), who also got a stone-free rate of 88.9% and >99%, respectively[16].

CONCLUSION:

Ultra-mini PCNL is safe and effective in achieving a higher stone-free rate and allows a short treatment period. UMPCNL plays an important role in treating renal stones < 2cm with less blood loss, shorter hospital stay, less need for blood transfusion and less postoperative pain. UMPCNL is less invasive, so minimal scar marks and minimal morbidity.

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