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SAFETY AND EFFICACY OF MINI-PERCUTANEOUS NEPHROLITHOTOMY(PCNL) IN RENAL OR UPPER URETERIC STONE >1CM

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ABSTRACT

Background: The advent of minimally invasive techniques like percutaneous nephrolithotomy(PCNL), retrograde intrarenal surgery(RIRS), extracorporeal shock wave lithotripsy(ESWL) have revolutionised the treatment of renal stone. PCNL is based on creation of appropriate percutaneous renal access, fragmentation of stone and removal of the stone. Conventional PCNL have been modified into mini-PCNL by the use of smaller tract size with the advantage of lesser complication rates and less postoperative pain. This study was done to see the efficacy and safety of mini-PCNL in the treatment of renal or upper ureteric stone >1cm in size. Methods: Between sept.2015 to june 2017 mini-PCNL was performed in 70 patients with the upper ureteric stone or renal stone of size >1cm. All patients were evaluated preoperatively with detailed clinical history, physical examination, blood and urine investigations and radiological examination. Under spinal or general anaesthesia, ureteric catheter was placed, percutaneous puncture of renal calyx was achieved and the tract dilated using amplatz serial dilator over the guidewire. Stone was fragmented using pneumatic lithotripter and removed. 6Fr DJ stent or nephrostomy was placed at the end of the procedure. Postoperative pain, complications and transfusion requirement were noted. Results were expressed as mean (SD) or rate (%). Medline, EMBASE and PubMed search was performed and the results were compared with other contemporary observational studies. Result: Mean operative time was 54.54±18.04mins. Mean hospital stay was 2.45 days. Mean postoperative pain score was 3.27. Fall in Hb level was 5.14% which was not statistically significant (p-value 0.1.) Postoperative complications were fever in five patients (7.14%), urosepsis in one patient (1.4%),hemothorax in one patient(1.4%), irrigation fluid accumulation in two patients (2.9%), hematuria requiring embolisation in two patients (2.9%)and transfusion requirement in three patients(4.3%). There were no organ injury or mortality. Stone free rate (SFR) was 88%. Conclusion:Mini-PCNL is a safe and effective treatment option for the renal or upper ureteric stone >1cm.

Key Words: PCNL, Renal, Ureter, Stone

INTRODUCTION

Renal stone disease is a common problem worldwide, especially in the areas with dry climate affecting about 10% of the global population with the lifetime risk being 6-12% in the general population1. Although tiny asymptomatic stones in the kidney do not need any treatment2, large and symptomatic stones need to be removed surgically or fragmented via extracorporeal shock wave lithotripsy (ESWL). Open surgical techniques like nephrolithotomy, pyelolithotomy used to be mainstay for treatment of such stones earlier which has now been replaced by various minimally invasive techniques like percutaneous nephrolithotomy(PCNL), retrograde intrarenal surgery(RIRS) or laparoscopic technique .

PCNL is based on creation of appropriate percutaneous renal access, fragmentation of stone and removal of the stone. PCNL was first reported by Fernstrom and Johansson in 19763 and its efficacy and safety for disintegrating and removing the stones

from the kidney was further demonstrated by Alken et al4 and wickham et al 5in 1982. Since then it has become the gold standard for the management of multiple stones, large stones or staghorn stones in the kidney. With the development of novel technologies the procedure has been refined and has become much efficacious as well as safer for the treatment of renal stone. Standard PCNL uses tract of size 24-30 Fr for renal access but recently the procedure is done with the use of smaller tract of sizes 11-20Fr which has been named mini-PCNL6. Desai et al developed 4.85 Fr seeing needle and used it in a 4.85 Fr tract size without a working sheath to perform PCNL, which was called micro perc7. The development of smaller calibre, longer, and more nimble ureteroscopes has driven the revolutionary advance of treating intrarenal calculi using retrograde ureterorenoscopic approach. Ultramini-PCNL is another novel technique using a novel 6 Fr mininephroscope through an 11– 13 Fr metal sheath to perform holmium:YAG laser lithotripsy8.

The aim of present study was to study the efficacy and safety of mini PCNL for the management of renal or upper ureteric stone of sizes >1cm.

PATIENT AND METHOD

This is a prospective observational study conducted among the patients whose PCNL was done in Chitwan Medical College from September 2015 to June 2017. The ethical committee approved of the study and consent was taken from all the patients for the study.

Inclusion criteria-

1. Renal or upper ureteric stone >1cm
2. Age>16years

Exclusion criteria

1. Congenital anomaly
2. Coagulopathy
3. Urosepsis
4. Renal insufficiency
5. Conversion to open

All patients were evaluated with detailed clinical history, physical examination, renal function, urine routine and culture examination, bleeding profile and haematological examination. Patients with UTI received preoperative antibiotics. Preoperative imaging was done through intravenous urogram or CT urogram. The procedure was performed under either spinal anaesthesia or general anaesthesia depending upon the choice of the surgeon. Initially ureteric catheter was placed cystoscopically after which patient was placed on prone position with cushions placed ventrally to lift the abdomen. Percutaneous renal calyceal puncture was obtained under fluoroscopic guidance using 18gz needle through the calyx that provided optimal stone access. 0.038 or 0.035 guidewire was inserted after successful puncture as ascertained by the flow of urine from the needle. Over the guidewire serial amplatz Teflon dilator was inserted to dilate the tract. Tract was generally dilated upto 16-22 Fr depending upon the stone size. Amplatz sheath was then slipped over the dilator. 14 fr nephroscope was inserted and the stone fragmented using pneumatic lithotripter. Stone fragments were removed using continuous flow irrigation as well as using endoscopic forceps. At the end of operation 6fr DJ stent was placed. Nephrostomy tube was placed only if there was suspicion of residual stone.

Postoperatively antibiotics and analgesics were continued. Postoperative pain was assessed using visual analog scale. Patients were discharged on postoperative day 2 or 3 if no complications were seen. Postoperative ultrasonography or CT scan was done to see for the residual stone. Stone free rate(SFR) was described as stone fragments <2mm. DJ stents were removed after 2-4 weeks postoperatively. A complication was defined as any adverse event occurring within 30 days of operation and graded by modified clavein dindo classification.[9]

STATISTICAL ANALYSIS:

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS), version 15 for Windows. Results were expressed as mean (SD) or rate (%). Medline, EMBASE and PubMed search was performed for observational studies reporting data on mPCNL for comparision of the data with other contemporary mPCNL.

RESULTS

Patient characteristics

Total of 70 patients were operated during the study period among whom 39 patients were male and 31 were female. The mean age was 38.01±13.52 yrs. 31 patients underwent left sided mini-PCNL whereas 34 patients underwent right sided mini-PCNL. Bilateral mini-PCNL was done in five patients whose data for each side were evaluated separately. The mean stone size was 2.11±0.7cm. Twenty five cases had stone in renal pelvis, five cases had stone in upper pole, eight cases had stone in mid pole and thirteen cases had stone in lower pole. Staghorn calculi were present in eight cases and eight cases had multiple stones in different calyces. In eight patients mini-PCNL was done to remove the stone of upper ureter. 33 cases had mild hydronephrosis, 30 cases had moderate hydronephrosis and four cases had severe hydronephrosis. There was no or minimal hydronephrosis in eight cases.

Table 1: Patients' and stone characteristics

Total no. of patients	70
male	39(55.7%)
female	31(44.3%)
Mean age	38.01±13.52yrs
Position of stone	
Right	34(48.6%)
Left	31(44.3%)
Bilateral	5(7.1%)
Stone site	
Renal pelvis	25(33.3%)
Upper ureter	8(10.7%)
Upper pole	5(6.7%)
Middle pole	8(10.7%)
Lower pole	13(17.3%)
Staghorn	8(10.7%)
Multiple	8(10.7%)
Hydronephrosis	
Absent	8(10.7%)
Mild	33(44%)
Moderate	30(40%)
Severe	4(5.3%)
Mean stone size	2.11±0.7cm

OPERATIVE PROCEDURE:

Procedure was performed under spinal anaesthesia in 60 patients and under general anaesthesia in ten patients. During initial experience of the surgeon general anaesthesia was the preferred anaesthesia of choice but with experience spinal anaesthesia was found to be as effective in term of intraoperative analgesia for the patient. All the procedures were done in prone position. Renal access was achieved via single tract in all but two cases where double tracts were created. Among the patients whose single tract was made lower pole access was done in 36 cases, mid pole access was made in 32 cases, whereas in five cases upper pole access was made. Tract was dilated upto different sizes depending upon the size of stone. After the fragmentation and removal of stone the DJ stent was placed in all but four patients where nephrostomy was placed due to failure to completely clear the stone

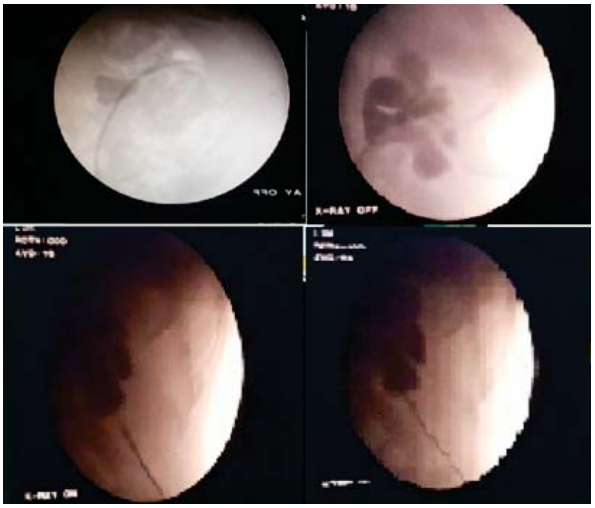
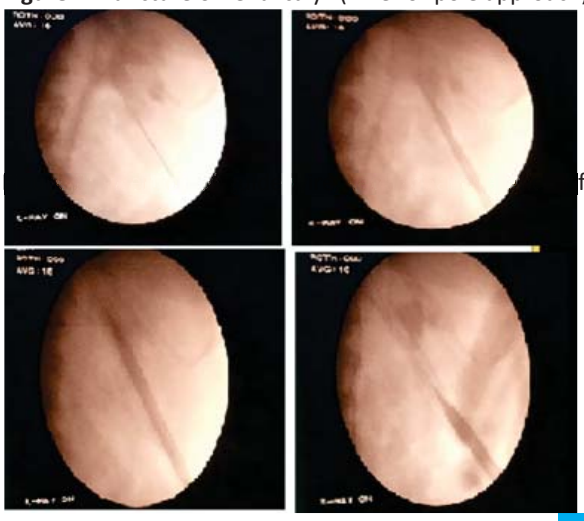


Figure 1: Puncture of renal calyx (inferior pole approach)



f tract

and insertion of working sheath

Mean operative time was 54.54±18.04mins. Mean hospital stay was 2.45 days. Mean postoperative pain score was 3.27. Mean preoperative Hb level was 13.96±0.96gm/dl whereas mean postoperative Hb level on POD2 was 13.24±1.0gm/dl with fall in Hb level being 5.14% which was not statistically significant (p-value 0.1.) Postoperative fever was seen in five patients (7.14%). One patient (1.4%) developed postoperative urosepsis requiring broad spectrum antibiotics. Hemothorax requiring chest tube insertion was seen in one patient(1.4%). Two patients (2.9%) developed postoperative ileus and abdominal discomfort related to irrigation fluid accumulation which resolved with conservative management. Two patients (2.9%) developed significant hematuria requiring embolisation. The first patient presented with hematuria on POD 13 while other developed hematuria on POD 8. Three patients(4.3%) required postoperative blood transfusion. Organ injury was seen in none of the patients and there was no mortality.

Figure 3: Fragmentation of stone using pneumatic lithotripter

Stone free rate (SFR) was 88%. Five patients (6.7%) had significant residual stone requiring repeat PCNL whereas in other patients it was managed expectantly. The chances of incomplete stone clearance were increased with the presence of staghorn calculi or multiple calculi and in those cases where excess intraoperative bleeding compromised visualization.

Table 2: Operative and postoperative data

Anaesthesia	
General anaesthesia	10
Spinal anaesthesia	60
Number of tracts created	
Single	73
Upper pole access	5
Mid pole access	32
Lower pole access	36
Double	2
Mean	
Operative time	54.54±18.04mins
Hospital stay	2.45days
Fall in Hb level	5.14%(p-value0.1)
Postoperative pain score	3.27
Complications	
Fever	5(7.14%)
Urosepsis	1(1.4%)
Hemothorax	1(1.4%)
Irrigation fluid accumulation	2(2.9%)
Transfusion requirement	3(4.3%)
Bleeding requiring embolization	2(2.9%)
Organ injury	0
Mortality	0
Stone free rate	88%

DISCUSSION

With the advent of minimally invasive techniques like percutaneous nephrolithotomy(PCNL), retrograde intrarenal surgery (RIRS) , extracorporeal shockwave lithotripsy (ESWL) and laparoscopic techniques, the open surgery for renal stone is gradually becoming obsolete. American Urological Association Stone Guidelines Panel has classified ESWL as a potential first-line treatment for ureteral and renal stones smaller than 2 cm. Although ESWL is a low risk procedure, it often leads to persistent residual stone with success rate being 74% for renal stone and 88% for ureteric stone10. It can also be associated with significant renal colic related to the passage of stone fragments. RIRS is another minimally invasive measure for the treatment of renal calculi with lower complication rates, however with lower stone free rate11. It can

minimize the risks associated with bleeding and visceral injury, but sometimes the nonideal pelvicaliceal anatomy and poor durability of the flexible ureteroscopy may impact its success rate and applications12. PCNL is ideally preferred procedure of choice for large stone burden >2cm or >1.5cm for lower calyceal stone and the stone that do not respond to ESWL. Our study has shown that PCNL is safer alternative for even smaller stones which are symptomatic with minimal complications and higher stone clearance rate. Prospective randomized controlled trial by Albala et al 13 has shown it to be more effective than ESWL especially to remove lower pole stones larger than 10mm. PCNL can also be performed in horseshoe kidney, transplanted kidney, stones in calyceal diverticulum and in children. The AUA nephrolithiasis guideline panel has recommended PCNL followed by ESWL or repeat PCNL as a treatment modality for staghorn calculi14 in order to reduce infective complications, haemorrhage or hemothorax and achieve complete clearance of stone.

Standard PCNL uses 26-30 Fr access tract whereas mini-PCNL is defined as PCNL performed through tract < 24 fr15. Mini-PCNL was initially developed to treat the paediatric patients using 11Fr access sheath by Jackman16. The clearance rate of mini-PCNL was shown to be equivalent to the conventional PCNL. It had an added benefit of less blood loss. With the development of new technology in form of minimally invasive PCNL (MIP) system, the mini-PCNL has gained significant popularity17. The first generation MIP system had single-stage dilatation, automatic continuous low-pressure irrigation, and the novel additional method of stone clearance by the 'vacuum' effect 18. The MIP system has a 12-F nephroscope with a 6.7-F central channel, single-stage dilators and corresponding operating sheaths.

Main limitation of PCNL is technical. There is a steep learning curve for the surgeon for the creation of percutaneous renal access and thereby sufficient training is necessary. Most of the complications occur during the initial experience of the surgeon. When the surgical experience increases the duration of procedure, fluoroscopy time decreases and the stone free rate become higher. Complication rate significantly decrease after 45 cases.

Patient positioning has been one of the concern of debate regarding the optimization of the procedure without compromising the advantages of the procedure. Initial PCNL was performed in prone position which has become the most popular approach among the urologists. Anaesthesia related problem especially in a patient with compromised cardiopulmonary status , high risk conditions like morbid obesity or orthopaedic problems have induced for exploration of other positions for the procedure. Endoscopic combined intrarenal surgery (ECIRS) in Galdakao modified supine Valdivia position is a novel method that have been described which overcome the anaesthesia associated disadvantages in prone position as well as exploit the surgeon's versatility for an optimal outcome of the procedure as it allow simultaneous antegrade and retrograde access to the whole urinary tract[19]. A randomized controlled trial reported by Falahatkar et al compared supine with prone PCNL which showed stone free rate to be similar in both group. Operation duration was lower in supine group but transfusion rate was higher[20]. Our study has shown that with increasing experience of surgeon the procedure can be done safely under spinal anaesthesia making the prone positioning feasible even in high risk conditions and in patients with compromised cardiopulmonary status.

Percutaneous renal access is a crucial step in PCNL as it directly affects the success rate and complication rates of the procedure. The chances of injury to interlobar and arcuate branches are high when the puncture is not through the centre of renal papilla. Injury to the interlobar vessel was seen in 67% and 13% cases during upper pole infundibulum and lower pole infundibulum puncture respectively[21]. Percutaneous access is achieved under radiological guidance which can be done through various techniques including fluoroscopy, ultrasound or CT scan. Fluoroscopy is the most commonly employed method but the actual depth of the appropriate calyx cannot be well evaluated in it[22]. USG guided PCNL has been reported more frequently and has the advantage of absence of radiation. Dilation of the tract is commonly done by amplatz dilator although balloon dilation is regarded as most modern and safe technique[23].There are several methods of intracorporeal lithotripsy like pneumatic lithotripsy, ultrasonic lithotripsy and laser lithotripsy[24].At the end of the procedure the renal unit can be drained using nephrostomy tube or by placing retrograde applied ureteric catheter or DJ stent known as tubeless PCNL[25] .

Difficult cases are patients with distorted calyceal system, with former renal operations, with non dilated system and in systems where only little space is available for manipulation like calyceal diverticula or staghorn calculi. Loss of tract is often due to wrong access, not following the geometry of ideal access, creating a closed tract through calyx into the renal pelvis outside the renal hilum. Poor vision due to bleeding is another cause of incomplete clearance of stone.

Although PCNL is considered safe procedure, it can be associated with several complications. The common

complications following PCNL are postoperative transfusion requirement, bleeding requiring embolisation, urinoma, sepsis, fever, thoracic complication, organ injury and death[26]. Bleeding is one of the most common complications associated with PCNL. Predicting factors for blood loss have been body mass index, multiple puncture, tract size, operation time, stone size, stone localization, previous surgery or ESWL and degree of hydronephrosis. Different series have shown postoperative transfusion requirement to be 0-20%. In most cases bleeding are self limited and do not require any radiological or surgical intervention. However massive haemorrhage and continuous bleeding require renal arteriography and selective arterial embolization in upto 0-1.5% cases.

Irrigation fluid accumulation and urinoma formation have been reported in 2–7% of cases[27]. Prolonged operative time and tear of renal pelvis mucosa are the factors associated with irrigation fluid accumulation. Diuretic can be effective for slight accumulation of irrigation fluid. Massive accumulation of fluid may even cause abdominal compartment syndrome and requires ultrasound guided drainage of the fluid. Post PCNL fever can be seen in upto 0-32% of cases, however severe sepsis have been seen in 0.3-1.1% cases. DM, staghorn stones, degree of hydronephrosis, duration of the operation and number of tracts are risk factors for post PCNL fever, while number of stones, intraoperative blood loss, duration of the operation and residual stones are risk factors for post PCNL sepsis. Thoracic complication can be seen in 0-11% of cases and can be in form of hemothorax, pneumothorax, pleural effusion. Different organs that can be injured during PCNL are spleen , liver and hollow viscera. Injury to the spleen or liver often occurs in the setting of associated anatomic abnormalities, such as splenomegaly or hepatomegaly. Injury to hollow viscera, such as the colon, can occur in 0.2% to 1% of patients. Several factors are associated with an increased risk of colonic injury, including left percutaneous renal access, female gender, thin body habitus, horseshoe kidney, and a history of bowel or renal surgery resulting in heterotopic positioning of the bowel.

In our present study, the complications seen were equivalent to other contemporary series. During the initial experience of the surgeon there were increased instances of incomplete stone clearance and complication rates however the stone clearance rate was higher after initial 40 cases.

CONCLUSION

Mini- PCNL is a safe and effective treatment option for the stones in kidney and upper ureter of sizes >1cm.

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