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Original Article

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Tubeless Supine Mini-Percutaneous Nephrolithotomy (mini-PCNL) for Renal Stone: 50 Cases Experiences

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Abstract:

Background: *To present our experience in performing tubeless supine mini-percutaneous nephrolithotomy and to compare our results with those reported in the international literature.*

Patients and Methods: *The medical records of 50 patients that underwent supine mini-percutaneous nephrolithotomy were reviewed. The evaluated variables were: age, gender, stone location and size, surgery duration, success rate, and complications.*

Results: *The mean age of the patients was 42.28 + 13.06 years (20-60) with predominance of males (30:20). Mean stone size was 1.5+ 0.65 cm (range: 1- 3 cm), predominantly on left side (32:18) and the mean operative time was 40.6 + 4.8 min (range: 30-60 min). Topography of the calculi were pelvic, 24 (48%); caliceal system; lower 12 (24%), middle 11 (22%), upper 3 (6%). The stone clearance rate was 98%, and the complication rate was 6% (Clavien: I).*

Conclusion: *Supine mini-percutaneous nephrolithotomy is safe and efficacious, with a high success rate, low complication rate, and undisputable advantages of anesthesia management.*

Introduction:

Urolithiasis is a common disease of urinary system. Poor oral fluid intake, high intake of protein, oxalate and salt are all common risk factors for the development of stones.[1] Men appear more frequently than women.[2] The reported incidences is 7%-13%, 5%-9% and 1%-5% in North America, Europe and Asia, respectively[3,4] and the recurrence rate is approximately 20%-50% within 5 years.[5] Generally, the renal calculi may cause obstruction, repeated infection, and progressive renal function deterioration, so an active stone removal is required.

Based on the patient's initial symptoms, urolithiasis is treated with a combination of conservative, medical and surgical procedures.[6] Surgical treatment was the only strategy to manage renal stones in 1900s, however, its activity was limited due to the major side effects including loss of blood, infection, high fever and damage to surrounding organs.

Percutaneous nephrolithotomy (PCNL) was considered as a safe and effective method for removing kidney stones with a relatively low incidence of complications.[7] The first percutaneous nephrostomy was performed in 1865 by Tomas Hiller. Goodwin et

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al.[8] reported their initial experience in percutaneous nephrostomy for the drainage of an infected hydronephrotic kidney in 1955. Fernstrom and Johansson[9] made a tremendous change in the field in 1976 by conducting the first percutaneous nephrolithotomy (PCNL) instead of open surgery. Few years later Alken et al[10] published their series of percutaneous extraction of stones using an ultrasonic lithotripter. From then onwards the procedure has won great acceptance and its indications are well described.[11]

According to the current guideline on urolithiasis management, percutaneous nephrolithotomy (PCNL) was still recommended as the standard management for renal calculi ≥2cm, while extracorporeal shock wave lithotripsy (SWL) and retrograde intrarenal surgery (RIRS) were recommended as the first-line treatment for renal calculi <2cm.[12] In recent years PCNL has gained attention as it leaves patients stone free in a single setting and is a minimally invasive approach. It has prodigious results and at the same time minimizes morbidity and complications.[13]

The percutaneous nephrolithotomy (PCNL) is usually done in prone position due to easier access to the kidney being a retroperitoneal organ.[14] However, during this position, the major complications like hemorrhage and lesion to other organs have been reported in a 0.9-4.7%.[15] It is usually carried out in general anesthesia, so this position is associated with patient's incommodity and circulatory and ventilatory haphazards especially in obese patients.[16]

To overcome these complications and morbidity, various modifications in the position for PCNL have been reported related to the procedure. These include reverse lithotomy, spine position, lateral decubitus, supine modified Valdivia Galdakao, Valdivia Barts modified and supine Bart's modified.[17] These positions have been reported as safe and effective when compared to the conventional prone PCNL but they never went out to be very popular. Theoretical advantages of supine position include; less radiation to the hands of surgeon by not having them in the operatory field, less surgical time, decreased risk of orthopedics and neurological complications, less liquid absorption, calculi drainage facilitation by gravity, less personnel required to accommodate the patient, easy access to respiratory track at any moment and simultaneous antegrade and retrograde access with less restriction to scope movement due to free flank. The theoretical disadvantages of supine position include; increased real mobility, longer percutaneous track, collapsed renal cavity at every moment of surgery and difficult access to the superior calyx.[18]

The complication following prone PCNL was higher than supine PCNL in Valdivia et al.'s study[19], specically reected in fever (11.1% vs. 7.6%, P = 0.001) and blood transfusions (6.1% vs. 4.3%, P = 0.026). So it is clear that prone position is not the only way to perform PCNL and many urologist all over the world use supine position as an excellent alternative to prone position.[20] In Bangladesh there are very few urologists who perform PCNL in supine position so we wanted to share our experiences and recommendations in this regard.

Materials and methods:

This retrospective observational study was conducted in Urology department of Sylhet M A G Osmani Medical College Hospital, Sylhet from June 2021 till May 2023 in patients with aged 20-60 years old. Patients with pregnancy, radiolucent stone, abnormal upper urinary tract anatomy (including horseshoe kidney, renal duplication, ureteropelvic junction obstruction, or ureteral stricture), preoperative acute pyelonephritis or urosepsis, uncorrected coagulopathy, concurrent malignancy, multiple-tract PCNL, concurrent bilateral urinary tract endoscopic stone surgery were excluded. Finally, a total of 50 patients with renal stone of 1-3cm were included in the study.

All patients underwent noncontrast-enhanced spiral CT of the KUB region to evaluate the stone location, burden and radiolucency. The stone burden was determined by measuring the longest diameter on CT; if there were multiple calculi the burden was defined as the longest diameter of large stone. A preoperative sterile urine culture was mandatory. Injectable co-amoxiclav and amikacin were given as prophylaxis to patients at the time of surgery, and was continued for 48 hours afterwards. All of the patients were operated under general anesthesia. All mini-PCNL operations were performed by the same urologist.

The patient was placed in the flank-free oblique supine modified lithotomy (FOSML) position under general anesthesia. Ipsilateral 5 French ureteral catheterization was performed initially to create artiûcial hydronephrosis by manual injection of diluted contrast and opacification of pelvicalyceal systems. The duration of operation was calculated from the time of initial puncture until removal of sheath.

Figure 1: *Patient Position.*

Figure 2: *Puncture site.*

Figure 3: *Mini Nephroscope & Shah Suoer perc sheath*

We marked the initial puncture site, that lies behind the posterior axillary line under the level of the 12th rib, targeting the lower or middle posterior calyces. Under fluoroscopic guidance an 18 G needle was used to puncture the collecting system. The needle must remain almost horizontal or slightly inclined upward towards the operating table. A 0.038 inch guidewire was inserted, followed by dilatation of the tract upto 18 Fr, followed by the insertion of a 18 Fr Shah super perc sheath. After tract dilatation we used a 12 Fr Karl Storz mini-nephroscope with intracorporial pneumatic lithotripsy (ICPL) for stone fragmentation. The volume of irrigation fluid used and the duration of fluoroscopic exposure were recorded at the end of the procedure. Hemodynamic changes and any need for transfusion were evaluated and recorded during the first 24 h after surgery. A radiological examination was used to assess stone clearance on the first day after surgery, with either a plain film of the abdomen or CT of the urinary tract. Stone clearance was defined as no stone or clinically unsignificant stone particles less than 0.4mm post operatively. Perioperative complications were classified according to the modified Clavien grading system.

Results:

A total of 50 patients enrolled in current study. The mean age was of 42.28 + 13.06 years (range: 20-60 years). Male patients were more frequent as compared to females. The mean stone size was 1.5+ 0.65 cm (range: 1- 3 cm) and the mean operative time was 40.6 + 4.8 min (range: 38-60 min). The most affected kidney site was left (n=32). 24 (48%) patient have stone in renal pelvis, 12 (24%) in lower calyx, 3 (6%) in upper calyx and 11 (22%) in middle calyx. There was 1 (2%) residual stone that was in upper calyx. Mean post operative hospital stay was 02 days. Complications were reported in 3 (6%) patients that were managed by transfusion and incidence of urosepsis 0 (0%) and urinary fistula was 0 (0%).

Table 1: *Frequency of variables and patient values (n=20)*

Variables	Values
Age in years(Mean±SD)	42.28 + 13.06
Gender (male: female)	30:20
Stone size(mm)	1.5+ 0.65
Site of kidney (Right: Left)	18:32
Site of stone, n (%)	
Renal pelvis	24 (48%)
Upper calyx	3 (6%)
Lower calyx	12 (24%)
Middle calyx	11 (22%)
Stone number, n (%)	
Single	42 (84%)
Multiple	6 (12%)
Staghorn stone	2 (4%)

Table II: *Intraoperative parameters.*

Variables	Values
Operation time (Mean±SD)	40.6 + 4.8
Target calyx	
Upper, n (%)	0 (0%)
Middle, n (%)	16 (32%)
Lower, n (%)	34 (68%)
Success of renal access creation in the first attempt, n (%)	45 (90%)
Puncture depth, cm (mean±SD)	8 + 1.4
Residual stone, n (%)	1 (2%)
Complications, n (%)	3 (6%)

Discussion:

Kidney stones can affect all ages, genders, and races. In this study, it was seen that men were more dominant compared to women, with male to female ratio of 30:20. These results were similar to the epidemiological studies that also showed that kidney stones are more common in men between the ages of 20 and 49 years old.[21] However, this study found that the average age of the patients with kidney stones treated by PCNL was 42.28 + 13.06 (Mean±SD) years old, with a range of 20-60 years. This difference in the mean age can be due to differences in the selection of the management of kidney stones.

In 1941 Rupel and Brown[22] passed a cystoscope down first an openly placed nephrostomy tract for percutaneous renal instrumentation. Fourteen years later, in 1955, Goodwin and associates[23] described percutaneous puncture of the kidney in the prone position. Twenty-one years later, Fernstrom and Johansson[11] credited first this approach to undertake percutaneous nephrolithotomy. In the late 1970s and early 1980s, Alken et al.,[10] Clayman,[24] and Das Gupta et al.[25] developed the clinical technique of percutaneous nephrolithotomy. While the original articles provide the prone approach as the standard approach for PCNL.

PCNL has traditionally been performed in a prone approach. However, the multiple advantages of the supine approach evidenced in adults , such as lower thoracoabdominal restriction, easier monitoring of the endotracheal tube and lower risk of cervical and occular trauma,[26] without compromising effectiveness in terms of SFR 74.1 to 92.5%[8] versus 86.2 to 98%,[27] have increased popularity in this technique.

Initially, percutaneous surgery was a staged procedure where the kidney was punctured initially by a radiologist under local anesthesia and sedation in the radiology department. In this circumstance, placing the patient in the prone position did not present any particular difficulties. But now renal puncture is performed by a urologist, making it a single-stage procedure (Lashley and Fuchs[28]). The prone position is also less attractive because of the need to reposition the patient.

Supine position offers many advantages to the anesthesiologist especially in obese patients and patients with high surgical risk.[29] Any invasive procedure like central line catheter, cardiac defibrillation or re intubation is much easier in supine position as compared to the prone.[29]

It was believed that the supine approach may have put the colon at more risk of injury than the prone position. Boon et al. [30] describes on the basis of studies of CTs, estimated a risk of colonic injury of 16%, but this has not been reflected in practice. In 1998 Valdivia Uria and associates[14] first described the supine position for percutaneous stone surgery. Based on CT studies, they suggested that the colon floats away from the kidney when the patient is in the supine position; this makes the colon less likely to be injured by a puncture made in the posterior axillary line.

The estimation of operative time is controversial. When exactly the surgery starts and what is the hall mark of ending the surgery is both well-defined.[31] In a meta-analysis by Liu et al. demonstrated a reduction of time upto 28% in supine position when compared to the prone position, in a group of 389 patients.[32] Mean operative times were reported by Valdivia et al. and Falahatkar et al. of 85 and 98 min respectively. Hoznek et al. reported a mean (range) operative duration of 123 (50–245) min.[33] In another study by de Sio et al. where a comparison between prone and supine position has been done , mean operative time in supine group was 74.7±25.1 min and less than prone group (106.87±17.5) with a significant statistical difference ($p < 0.0001$).[34] We had mean surgical time of 40.6 + 4.8 min, which was almost similar to some serial studies.

De Sio et al.[34] published an article of 170 patients; n=48 with mid calyx approach and n=122 with inferior calyx approach. They found similar results in stone clearance, time of surgery and complications in each group. In our study 34 (68%) patients were approached by inferior calyx and 16 (32%) by middle calyx and we

also did not find any significant difference in terms of stone clearance, surgical time and complications in these groups.

We used pneumatic lithotripsy in our cases. It is worth mentioning here that holmium laser have its own advantages over pneumatic lithotripsy but its high cost and low availability is a major hurdle in its use and it also takes more time for stone clearance. In a meta-analysis by Chen et al. showed that compared with Holmium laser, pneumatic lithotripsy significantly reduced the mean operative time (weighted mean difference = -11.52, 95% CI -17.06 to -5.99, $p < 0.0001$) and increased the early stone-free rate (OR 2.69, 95% CI 1.913.78, $p < 0.00001$) and the delayed stone-free rate (OR 2.12, 95% CI 1.40-3.21, $p= 0.0004$).[35]

Nephrostomy tube is used to guarantee the hemostasis, prevent urine extravasation and renal healing. In our study nephrostomy tube was not used due to less stone burden, no trans operative bleed or by not having any residual stone suspicion. More recently, it has also been proposed to additionally omit the placement of a post-operative nephrostomy (tubeless technique): in a small series by Nagele et al.[36] a tubeless mini-PCNL enabled a lower perioperative morbidity rate and hospital stay. In a meta-analysis by Xun et al.[37] proved that tubeless PCNL is associated with significantly shorter operative time, shorter hospital stay and shorter time to return to normal activities.

Limitations:

The main limitation of our study is small sample size. The another limitation is its retrospective nature and lack of a randomization of the treatment option offered to the patients.

Conclusion:

This study showed that the supine position for percutaneous stone surgery is safe and effective. In our experience supine position for PCNL is very effective and versatile technique especially in simultaneous treatment of middle or lower track pathology with low complication rate, easy management and very good stone clearance rates.

No Conflict Of Interest

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