Supine Ultrasound-guided Percutaneous Nephrolithotomy with Retrograde Semi-rigid Ureteroscopic guidwire retrieval: Description of an Evolved Technique

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Purpose: Ultrasound-guided PCNL in Galdakao-modified supine Valdivia (GMSV) position has taken into consideration during the last decade; however, guidewire slippage during tract dilatation is still a big concern in this approach. Here we presented our results of combination of this modification with ureteroscopic guidewire retrieval to ensure a safe and confident renal access.

Materials and Methods: From June 2015 to March 2016, 30 consecutive patients with renal stone of ≥ 2.5 cm were enrolled. After general anesthesia, all patients were positioned in GMSV position. Semi-rigid ureteroscopy up to the renal pelvis was performed by an assistant urologist. Ultrasound (US)-guided renal access and passage of guidewire was performed by another urologist after which the first urologist grasped and retrieved the guidewire from the renal pelvis to the ureter and then out of urethra. Stone manipulation was performed as standard PCNL. All patients were evaluated regarding age, stone burden, anthropometrics measurements, major and minor surgical complications, and stone free rate.

Result: Guidewire retrieval was successful in 26 patients (86.7%) and tract dilatation was achieved in all (100%) of this group. In other 4 patients (13.3%) retrograde endoscopic guide wire retrieval failed; in one patient, (3.33%) ureteroscope did not reach the renal pelvis because of tall stature; One patient (3.33%) had narrow calyceal infundibulum which prevented the guidwire passage along the stone to reach to the renal pelvis, and for two patients (6.67%) ureteroscope did not pass the ureteropelvic junction because of narrow ureteropelvic angle.

Conclusion: Guidewire retrieval seems to improve the results of US-guided GMSV position PCNL by eliminating the possibility of guidewire slippage during tract dilatation.

Keywords: percutaneous nephrolithotomy; nephrostomy access; supine position; Valdivia position; Ultrasound-guided.

INTRODUCTION

Pyelocalyceal system (PCS) access is the outmost important part of a successful percutaneous nephrolithotomy (PCNL) and is generally performed under fluoroscopic guidance in prone position. Protective barriers used by patients and physicians during this procedure are heavy and tiresome, and radiation exposure can still has its own hazard effect on the surgical team[1,2]. This led to some new innovative techniques that substitute fluoroscopy with sonography.

Ultrasonographic PCS access has some definite advantages. It is cheaper, provides three dimensional pictures during puncture while fluoroscopy provides only two dimensional pictures and accurate imaging of all tissues/ viscera like intestines and lungs along an intended nephrostomy tract is possible only under ultrasound guidance. Similarly imaging in numerous planes is possible simply by shifting, tilting and rotating the scanning head[3].

On the other hand, prone position has its own anesthetic concerns regarding patient positioning (especially in morbidly obese patients, cardiopulmonary high-risk patients or patients with skeletal deformities) and the difficulty of obtaining a retrograde access to the kidney when needed[4,5]. To overcome this issue some positional innovative techniques have been introduced including flank position, full supine position, Valdivia position, and Galdakao-modified supine Valdivia (GMSV) position[6,7].

Totally sonographic percutaneous access however has some limitations including kinking of guidwire, guidwire slippage out of the collecting system during tract dilatation which results in losing the percutaneous access. It is also difficult to follow guidwire placement, tract dilatation and final position of Amplatz sheath when we are using sonography to perform PCS access. To surmount these concerns in this study we introduced a new technique which consists of ureteroscopic guidwire retrieval from the renal pelvis to the ureter and then out of the urethra before safely dilating the renal access without concerns of guide wire slippage in GMSV position.

PATIENTS AND METHODS

Study population

Thirty patients who were referred to Imam Khomeini Grand Hospital, Ahvaz, Iran from June 2015 to March 2016 were enrolled. The inclusion criteria were age be-

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tween 20 and 70 years, and pelvic or calyceal stones that were larger than 2.5 cm in diameter. Patients with gross kidney anomalies like horseshoe kidney or ectopic kidney, and those with uncontrolled coagulopathies and/or orthopedic problems that restrict the Galdakao-modified supine Valdivia position were excluded from the study. Study was performed under terms of ethical committee of Ahvaz Jundishapur University of medical Sciences (IRAJUMS.REC.1395.741). All patients were informed regarding the nature of the study, benefits and possible complications and then an informed consent was obtained from each patient.

Study design

This prospective observational study was performed to report our surgical technique, outcomes and complication of a new technique in 30 consecutive patients who were candidate for PCNL for renal stone disease in Imam Khomeini tertiary Urology Department. Information regarding patients' age, height, weight, BMI, and stone burden (size and location, based on Spiral CT scan) were obtained and reported. (**Table 1**)

Surgical technique

All patients were admitted in the morning of the surgery day. Abdomino-pelvic spiral CT scan was performed for all patients to measure stone burden and to rule out retro-renal colon. The antithrombotic prophylaxis was administered based on American Urological Association best practice statement for the prevention of deep vein thrombosis[8].

Patient positioning and setting up

After induction of general anesthesia patients were positioned in Galdakao-modified supine Valdivia Position. To obtain this two jelly pillows were placed below the hip and thorax and the ipsilateral foot is placed in extension, while the contralateral foot is placed in full lithotomy position and then the upper torso was tilted at approximately 20 degrees and the ipsilateral hand was placed and secured on the chest using a long band while a pillow was placed between the arm and the chest. (**Figure 1**). Then preparation and draping was performed .

Ultrasonography machine (Samsung Medison Sono-Ace X8 Ultrasound system, South Korea) was placed ipsilateral and cephalad. C-arm and fluoroscopic instrument were available in the operating room as well. Video monitoring was placed contralaterally in front of the surgeon (**Figure 2**).

Performing ureterorenoscopy and artificial hydronephrosis

After introducing a safety wire and with the using of a guidwire, ureteroscopy was performed by a urologist colleague (6/ 7.5 French semi-rigid ureterorenoscope, Richard Wolf, Knittlingen, Germany). Intra-renal pressure was set to 60 cm H2O to make hydronephrosis. After passing the uretero-pelvic junction the next step was performed by another urologist.

Performing US-guided renal assessment, guidwire retrieval and through and through renal access

To the best of our experience, performing ureterorenoscopy just before the sonographic evaluation of the kidney made a good hydronephrosis which makes percutaneous access to the kidney easier (**Figure 3**). After decision making regarding the best PCS location for percutaneous access to the kidney and posterior to the posterior axillary line, an 18G Chiba needle was introduced to the targeted calyx under sonographic guidance. Dropping of liquid out of Chiba re-ensured the correct placement of the needle. Then a single J 0.038-in guidewire passed through the chiba needle to the kidney PC system, which was then grasped with ureteroscopic forceps under clear direct vision of ureteroscope and retrieved from renal pelvis to the bladder and then to the urethral meatus to make a good through and through access to the kidney (**Figure 4**).

Single-step renal access and stone manipulation

Then after dilatation of the tract with an 8 French dilator sheath, an Alken guide was introduced to the calyx. A 26 French Amplatz dilator was then placed over the Alken guide and Amplatz sheath was introduced to the PCS. During these maneuvers our surgical technician pushes the kidney from anterior side to fix the kidney in place. Subsequently a 24 F rigid nephroscope (Richard Wolf Knittlingen, Germany) was inserted to inspect the collecting system. Under direct vision stone fragmentation was performed using Swiss lithoclast pneumatic

Figure 1. Galdakao-modified supine Valdivia position.

Figure 2. Operating room setting up.

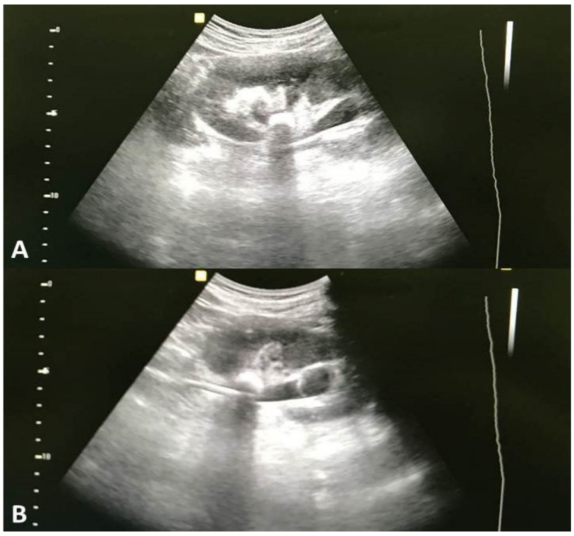

Figure 3. Sonography of the kidney: **(A)** Depicts a 3 cm right renal pelvis stone with posterior shadow. **(B)** The same patient after retrograde semi-rigid ureteroscopic access to the renal pelvis.

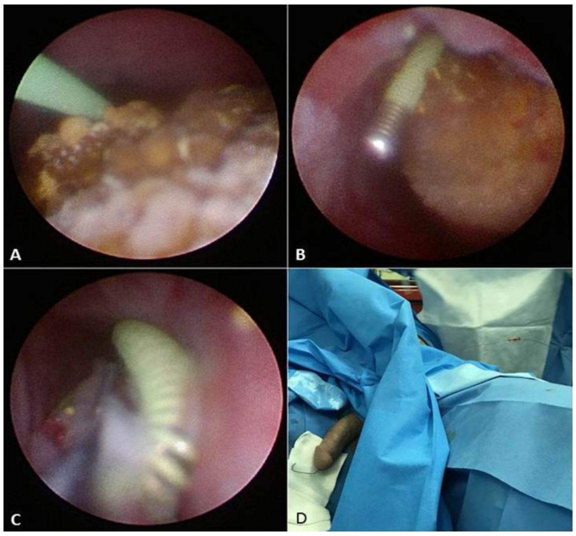

Figure 4. Guidewire retrieval: **(A)** ureteroscope reached the renal pelvis over the safety wire. **(B)** J 0.038-in guidewire passed through the Chiba needle to the renal pelvis. **(C)** Guidwire grasped with ureteroscopic forceps under clear direct vision of ureteroscope. **(D)** Guidwire retrieved from renal pelvis to the bladder and then to the urethral meatus.

lithotripter. After stones fragmentation using ballistic energy, stone fragments removed with graspers and gravity. After Double J stent placement (if indicated), a 20 French nephrostomy tube placed in PCS at the end of operation and remained for 24 hours after which it removed. All patients were discharged the day after surgery.

Outcome assessment

Blood transfusion and any post-operative complication were recorded. A sonography and kidney-ureter-bladder (KUB) X-ray was performed two weeks after operation to evaluate the stone free status and patients were considered stone free if the residual stone size were ≤ 3 mm.

Statistical Analysis

Categorical data are reported as number (percentage). Continuous variables were presented as mean ± SD. The Shapiro-Wilk's test was used to examine the normality assumption of quantitative variables. The statistical software SPSS 18.0.0 (SPSS Inc. Chicago, IL, USA) was used for all data analyses.

RESULTS

Patients' demographic data are listed in **Table 1**.

Of 30 patients, 22 (73%) were symptomatic for flank pain 18 (60%), hematuria 7 (23%) recurrent urinary tract infection 4 (13%), and renal colic 3 (10%). Percutaneous renal access was gained in Galdakao-modified supine Valdivia position under sonographic guidance in all 30 patients.

Guidewire retrieval was successfully performed in 26 (86.7 %), however, we were not able to do so in 4 (13.3 %) patients: ureteroscope did not reach the renal pelvis because of tall stature (188 cm long) in one patient (3.33 %), narrow calyceal infundibulum which prevented the guidwire passage along the stone to reach to the renal pelvis in one patient (3.33 %), ureteroscope did not pass the ureteropelvic junction because of steep and narrow ureteropelvic junction in two patients (6.67%).

Table 1. Patients' demographic data.

	Male	Female	Total
Number of patients (%)	20 (66.7%)	10 (33.3%)	30 (100%)
Age, year, Mean ± SD(range)	43.5 ± 14.9 (22-72)	51.4 ± 13 (32-70)	46.1 ± 14.6 (22-70)
Height, cm, Mean ± SD (range)	173.7 ± 5 (165-188)	161.6 ± 5.7 (150-170)	169.7 ± 7.8 (150-188)
Weight, Kg, Mean ± SD(range)	80.4 ± 15.8 (42-127)	72.1 ± 6.3 (56-78)	77.6 ± 13.8 (42-127)
BMI, Kg/m2, Mean ± SD(range)	26.5 ± 4 (15.2-35.9)	27.6 ± 1.6 (24.9-29.3)	26.8 ± 3.4 (15.2-35.9)
Stone burden, mm, mean ± SD			
Total	31.1	27.25	29.82
Upper calyx	N/A	N/A	N/A
Middle calyx	25.7 ± 15.2 (11-57)	22 ± 4.2 (19-25)	24.9 ± 13.3 (11-57)
Lowe calyx	16.7 ± 6.2 (10-25)	18.6 ± 8.5 (10- 30)	17.3 ± 6.7 (10-30)
Pelvis	26.5 ± 8.7 (17-42)	30.8 ± 9.4 (20-46)	27.9 ± 8.9 (17-46)
Stone Number			
Total	1.35	1.1	1.27
Upper calyx	N/A	N/A	N/A
Middle calyx	7	2	9
Lowe calyx	9	4	13
Pelvis	11	5	16

Abbreviations: SD, standard deviation; BMI, body mass index; N/A, not applicable.

Tract dilatation was easily performed in all (26 out of 26) cases in whom guidewire retrieval was successful. In the group of patients whom guide-wire retrieval failed, tract dilatation performed correctly in three cases; however in one case (25%, one of 4) of patients in this group the guide wire slippage happened during tract dilatation and another access under fluoroscopic guidance in the same position was obtained.
In one patient simultaneous trans-ureteral lithotripsy of a 1cm proximal ureteral stone was performed. Antegrade ureteral stenting failed in two patients; however retrograde Double J stenting was easily performed by ureteroscope for them.
Stone free rate in this study was 96.7% (29 out of 30). Mean operation time was 68 minutes (54- 95 minutes) and Mean access time was 8.4 minutes (5- 14 minutes). Post-operative fever happened in one patient (3.33%). No major surgical complication or blood transfusion (target hemoglobin of 10 g/dL) was seen in our study population.

DISCUSSION

In this study we reported our technique of performing US-guided PCNL with simultaneous semirigid ureteroscopy for creating through and through guidwire retrieval in GMSV position. The endeavor of this modification is to warrant a safe access to the PCS while maintaining all merits of supine and US-guided PCNL. Chiba insertion under direct vision of ureteroscope not only has the advantage of making an artificial hydronephrosis which makes US-guided access simpler but also retrograde guide wire retrieval raise the confidence of access dilatation over a non-removable guidewire. Other advantages of this combination technique include: The ability to perform simultaneous transurethral lithotripsy (TUL) in cases of stone migration into the ureter; The ability to push back the proximal ureteral stones to PCS, and the possibility of retrograde double-J catheter insertion in cases of antegrade failure.
Since the first report of first percutaneous renal access in 1955 by Goodwin[9] and performing the first PCNL in 1976[10] many different modifications has been invented. Sono-guided PCNL to reduce radiation exposure has been taken into consideration in the last decade and its safety and feasibility has been proven by different authors[11-18]. Also some authors reported different supine and modified supine position whether fluoroscopic or sono-guided PCNL with encouraging results [3,11,15-21].
Falahatkar and colleagues showed the safety and feasibility of totally sono-guided supine PCNL with similar outcomes compared with fluoroscopic supine position PCNL. They enumerate the major advantages of their technique as elimination of radiation exposure to the surgeon and the operating room staff, avoidance of contrast material administration, identification of all the tissue between the skin and kidney, and decreasing energy expenditure of the surgeon as it was not necessary to wear a lead shield[12].
Disadvantages of the supine position include kidney movement anteromedially during tract dilatation as described by Zhou and coworkers[22]. Solo sonographically guided PCNL has been reported with excellent results[23,24]. We reduced kidney movement by simultaneous push back of the kidney by assistant's hand during tract dilatation.
We also placed all patients in GMSV position and conducted all the procedures under sonography guidance and performed retrograde semirigid URS for all the patients to retrieve the guidwire into the bladder and out of urethra. It gave us the open hand to do simultaneous procedures such as TUL and proximal ureteral stone push back into the renal pelvis and we agree with their conclusion that this technique simplifies the surgical steps and it is more favorable for the anesthesiologists, surgeons, operating room staff and above all for the patients.
We also found that the BMI, weight, stone size and stone location has no relationship with the success rate of our method and supine sonographic assisted retrograde semirigid ureteroscopic guidwire retrieval for nephrostomy access in PCNL is safe and feasible for the majority of patients.
In our study we found the GMSV position a suitable position for sonographic assisted PCNL and the anesthetists and operating room technicians were satisfied with the position and its benefits which mentioned previously.
The present study has some limitations. First, this study is performed during surgeon's learning curve; however, the results and complications are acceptable and comparable to other studies. Second, this is an observational study with limited sample size and prospective randomized controlled trials with larger sample size are needed to evaluate this new technique.

CONCLUSIONS

Supine sonographic assisted retrograde semirigid ureteroscopic guidwire retrieval for nephrostomy access in PCNL is a safe and feasible technique and reduces the risk of access failure during totally US-guided PCNL. However, this may be technically unobtainable in tall patients, steep and narrow UPJ, and patients with narrow calyceal infundibulum. Galdakao-modified supine Valdivia position gives the urologist an open hand to perform multiple procedures simultaneously with reducing the anesthesiology risks of prone position. Totally sonographic PCNL reduces the risk of X-ray radiation for all of the operating room attendants.

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