Supine Percutaneous Nephrolithotomy
PRO

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Purpose: To share the experience of the authors with the urological family in the world by the review of literature on supine percutaneous nephrolithotomy (PCNL).
Materials and Methods: We have searched all the available databases, including PubMed or MEDLINE and Embase Biomedical Database to find any English articles related to supine PCNL from 1998 to 2010. Of 17 studies, 11 were case series and 6 were comparative.
Results: A total of 1914 patients were studied. Only the results of mean operation time were significant. Supine PCNL offers several advantages, including less operation time, less patient handling, needing only one drape, easier access to the urethra and upper calyces, facilitation of drainage of stone fragment with the Amplatz sheath, less anterior kidney displacement due to lying the kidney in its normal anatomical position, less risk of the colon injury, more tolerable for the patients with pulmonary or cardiovascular disease, and better for morbid obese patients. The overlap density of the vertebrae in the semi-supine position can be avoided. Furthermore, the fluoroscopy tube is far from the puncture site; thus, the space is open for the surgeon to work and the surgeon can perform the procedure in a more comfortable seated position.
Conclusion: The study showed that PCNL in the supine position is feasible. Although supine PCNL has numerous advantages, it is not routine in many surgical centers throughout the world. The practice of supine PCNL will be popular when the academic centers be encouraged to start it.

Keywords: percutaneous nephrolithotomy, supine position, urolithiasis

Urol J. 2011;8:257-64.
www.uj.unrc.ir

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) has numerous advantages and is the best treatment modality for kidney stones larger than 20 mm. It has been traditionally performed in the prone position, but recently, there have been many reports about PCNL in the supine position and complete supine position.[1]

The prone position is not a good option because it needs repositioning the patient and there is probability of injuring the nerves, neck, and limbs. Furthermore, some patients, such as those with ankylosing spondylitis, severe lordosis, or kyphosis, can not tolerate this position. The prone position is not also favorable for patients with severe cardiopulmonary disease and morbid obesity.[2-8]

Supine position has numerous advantages, but it is not familiar by most of the endourologists. Although there is a little chance of the colon injury in the supine position comparing to the prone

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Received December 2010
Accepted May 2011

position, but most urologists are reluctant to perform it.[2-8]

Some studies reported that PCNL in the supine position was as effective and safe as PCNL in the prone position and is an alternative option for removal of renal calculi with PCNL.[6,7] The purpose of this study was to share the experience of the authors with the urological family in the world by the review of literature on PCNLs performed in the supine position.

MATERIALS AND METHODS

We searched all the available databases, including PubMed or MEDLINE (US National Library of Medicine) and Embase Biomedical Database® (Elsevier; Amsterdam, Netherlands) to find any articles related to PCNLs performed in the supine position. The keywords of *percutaneous nephrolithotomy*, *supine position*, *sonography*, *imaging*, *body mass index (BMI)*, *tubeless*, *upper pole access*, *previous open renal surgery*, and *tract creation* were used in various combinations.

Articles in which PCNL in supine or complete supine position alone have been discussed and those comparing two methods of PCNL were included in our review. We found 17 articles in English language from 1998 to 2010. Of 17 studies, 11 were case series and 6 were comparative.

The information regarding the total number of patients, male to female ratio, age, maximum stone diameter, affected side, positive history of extracorporeal shock wave lithotripsy, previous open or percutaneous surgery, BMI, operation time, length of hospital stay, stone-free rate, calyx puncture site, blind access to the calyx, transfusion, extravasation, fever or infection, conversion to open surgery, deep vein thrombosis, pleural effusion, colon injury, and mortality were collected.

RESULTS

The results of the literature review for PCNLs performed in the supine position are summarized in Table.[1,3,4,7,9-16] A total of 1914 patients in the age range of 32 to 55.9 years were studied.

Stones with a wide range of sizes were removed by PCNL with the patient being in a supine position. The majority of the studied patients did not have a positive history of extracorporeal shock wave lithotripsy, but most of them had a history of previous open or percutaneous surgery. The operation times ranged from 15 to 300 minutes. The stone-free rate was 70.5% to 95%. The most commonly puncture site was the lower calyx. Transfusion was needed in 0% to 20% of the patients. Extravasation occurred in 1.09% of the patients. The most common complication was fever that occurred in 10.25% of the patients. Conversion to open surgery was seen only in 3 patients. The reports of deep vein thrombosis and pleural effusion were sporadic and rare. No colon injury or mortality was reported.

DISCUSSION

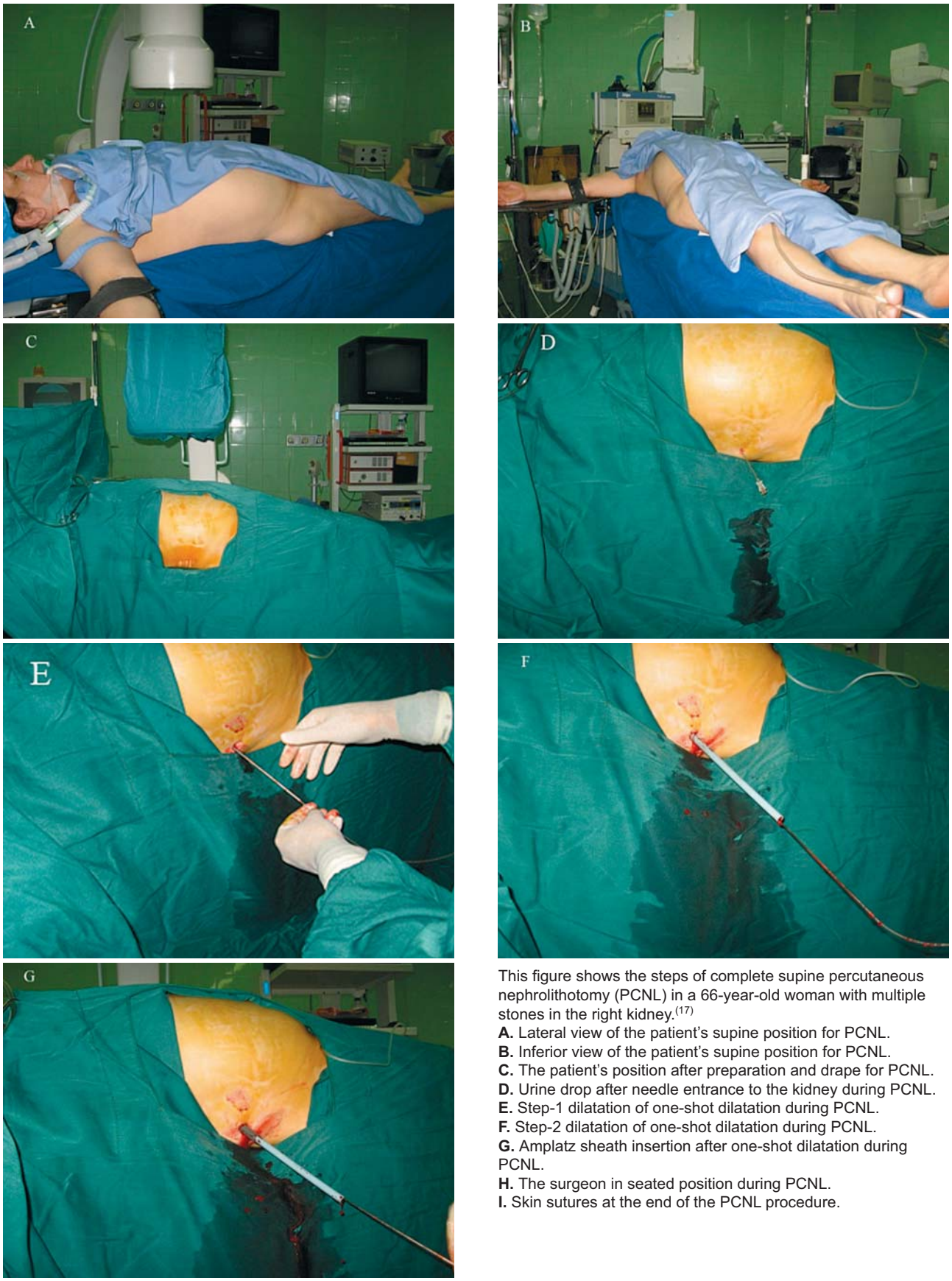
We perform PCNL as a well-known surgical procedure in the complete supine position without any towel under the patient's flank, and with no change in the leg position.[3] The steps of complete supine PCNL in a 66-year-old woman with multiple stones in the right kidney are illustrated in Figure.[8]

Although the supine position has many benefits compared with the prone position, the traditional prone position is acceptable by many urologists.[8] Falahatkar and colleagues compared the outcome of PCNL in the complete supine position with the standard prone position in 80 patients who randomly underwent PCNL.[3] They performed supine PCNL without the use of a rolled towel and without any change in the leg position. They suggested that complete supine PCNL is feasible when the flank was near the edge of operating table. The surgeons must avoid overlapping of the kidney with the metal density of the table. They showed that PCNL in the supine position has numerous advantages, including no need to change the position.[3,8,9]

Liu and coworkers performed a systematic review and meta-analysis on PCNL in the supine versus prone position. Although there was no difference between the positions with regard to success rate, complication, transfusion, and fever, the operation time in the supine PCNL position

The results of the literature search for percutaneous nephrolithotomy done with patients in the supine position.

Outcome	First Author, Year Published																
	Valdivia- Uria, 1998[31]	Shoma, 2002[4]	Ng, 2004[32]	Steele, 2007[33]	Manohar, 2007[26]	De Sio, 2008[17]	Neto, 2007[1]	Falahatkar, 2008[3]	Rana, 2008[5]	Zhou, 2008[34]	Basiri, 2010[14]	Scoffone, 2008[11]	Falahatkar, 2011[12]	Falahatkar, 2010[8]	Falahatkar, 2011[7]	Falahatkar, 2010[13]	Falahatkar, 2011[10]
Total (N)	557	53	67	322	62	39	88	40	184	92	19	127	18	117	20	28	81
Gender																	
Male	221	34	34	198	50	17	30	23	61	12	221	90	15	64	11	15	41
Female	242	19	33	124	12	22	58	17	31	7	242	37	3	53	9	13	40
Age (years), Mean ± SD	55.1	43.6	55.9	58	48 14.16	38	43.5 13.3	45.35	32	52.6	44		49.9	47.2	45.9 ± 13.2	45.8	44.75
Maximum stone diameter (mm), Mean ± SD/Range			29.2	15	316 278	34	36 19	40.6	35 to 120	20 to 100	29.2	23.8 ± 7.3	31.2	36	48.3	46.5	34.3
Side (n)																	
Right	248	27	31	152	20	25	40	8	248	27	31	65		64	14	13	46
Left	265	26	36	170	19	15	38	11	265	26	36	62		53	6	15	35
Previous shockwave lithotripsy (n)								15							9	9	
Previous open or percutaneous surgery (n)		16				4	55	15			10			33	6	12	28
Body mass index, Mean ± SD					24.28 4.69	28		25.6 3.5					26.9	27.1		27.7	
Operation time (minutes), Mean ± SD/Range	85			15-300	73.66	43	162.1 49.3	74.7		120 68	111	80 (25 to 225)		98	102.25	84.1	99.23
Hospital stay (hours), Mean ± SD/Range			209	72-144		103	129.6 74.4	80.02			86 33	122.4 ± 69.6	64.8	76.8			90.72
Stone-free rate (%)		89	76	91	95	88.7	70.5	80	84	82.6	84	87.4	77.8	77.77	85	75	72.45
Calyx puncture site (n)																	
Upper	2	8			5	0		3	6		1	116			20	0	
Middle	23	13			25	7		2	46		3	9			0	6	
Lower	517	42			32	32		27	132		15	2			0	22	
Transfusion (%)	1	9	3	3.7	3.2	0	8	20	4	1.1	5	3.15	5.6	14.5	5	14.3	14.8
Extravasation (n)		2		3	7	4		5				5	0	0	0	0	0
Fever or infection (%)		4	19.4		18	5	13.6	2.5				27.55	5.6	6.8	5	10.7	4.9
Conversion to open surgery (n)	3		0		0	0	0	0	0	0	0	0	0	0	0	0	0
Deep vein thrombosis (n)			1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Pleural effusion (n)	0		0	1	0	0	0	0	1	0		0	0	0	0	0	0
Colon injury (n)	0		0		0	0	0	0	0	0	0	0	0	0	0	0	0
Mortality (n)	0		0		0	0	0	0	0	0	0	0	0	0	0	0	0



This figure shows the steps of complete supine percutaneous nephrolithotomy (PCNL) in a 66-year-old woman with multiple stones in the right kidney.[17]
A. Lateral view of the patient's supine position for PCNL.
B. Inferior view of the patient's supine position for PCNL.
C. The patient's position after preparation and drape for PCNL.
D. Urine drop after needle entrance to the kidney during PCNL.
E. Step-1 dilatation of one-shot dilatation during PCNL.
F. Step-2 dilatation of one-shot dilatation during PCNL.
G. Amplatz sheath insertion after one-shot dilatation during PCNL.
H. The surgeon in seated position during PCNL.
I. Skin sutures at the end of the PCNL procedure.

was significantly shorter than the prone position ($P < .00001$). They concluded that PCNL in the supine position is as effective and safe as PCNL in the prone position.[6]

De Sio and colleagues carried out a randomized clinical trial on PCNL with single access in 75 patients (39 patients in supine and 36 in prone position). They found no significant difference between the two groups in terms of stone-free rate ($P = .12$), mean blood loss ($P = .23$), and mean hospital stay ($P = .18$). The only significant difference was for mean operation time, which was shorter in the prone position ($P < .001$). No blood transfusions or visceral injuries were reported. They concluded that the supine position was safe in uncomplicated stones.[17]

Another study in 2010 evaluated the safety and efficacy of renal displacement technique in complete supine PCNL in 20 patients. The authors reported that subcostal approach with the lung inflation was feasible in the supine position. This technique helped the surgeon avoid the supracostal puncture.[18] In 2010, Falahatkar and associates determined the effects of the previous stone surgery on the results of complete supine PCNL in 81 patients. They reported that complete supine PCNL in patients with a history of stone surgery can be safe and effective.[10]

Scoffone and coworkers reported that simultaneous performance of PCNL and retrograde ureteroscopy (endoscopic combined intrarenal surgery) provided the most beneficial results in 127 patients. They concluded that this technique is safe and effective for the treatment of upper urinary tract abnormalities.[11] In another study, Falahatkar and colleagues evaluated the outcomes of tubeless complete supine PCNL in 117 patients. They demonstrated that complete supine PCNL is a good option for all the patients.[7]

In a study performed in 18 patients in 2010, the authors compared the amount of the kidney displacement in the complete supine position. They showed that the amount of the kidney movement was less than the standard prone position. It maybe another benefit of the supine position, reported by Falahatkar and associates.[12]

Benefits of Supine PCNL[3,5,7,8]

1) No need to change position; 2) Ability to perform ureteroscopy during PCNL; 3) Easier air way control by the anesthesiologist; 4) Easier PCNL of the upper calyceal stones; 5) Evacuation of stone fragments; 6) Decreasing operating time; 7) No contact between the patient's skin and water, which would prevent hypothermia; 8) Less kidney displacement; 9) Less retrorenal colon injury; 10) More comfortable for corpulent or obese patients, and the patients with respiratory or cardiac problems.

There are numerous advantages for the endourologists in performing PCNL in the supine position:[3,5,7,8]

1) The fluoroscopy tube is far from the working space.

2) Lack of overlapping of the vertebrae with the kidney.

3) Decreasing the total operating time.

4) Sitting position for the surgeon.

Supine PCNL is safe, effective, and suitable for most of the patients, and is feasible for all types of stones, such as calyceal, pelvic, multiple, staghorn, or upper pole calyceal stones.[3,7,8,18]

Imaging

Fluoroscopy has been the golden imaging modality standard for PCNL. Although numerous novel techniques have been done in PCNL by help of fluoroscopy, many researchers prefer to find an alternative method to reduce radiation exposure.[8,13,14]

Ultrasound-guided PCNL in the supine position

Because the endourologists are highly exposed to x-ray irradiation during endourologic surgeries and the procedure poses a potential health risk to the patients and endourologists, Falahatkar and coworkers performed the other study on 28 patients in 2009 and compared the results of ultrasound and fluoroscopically-guided PCNL in complete supine position. They showed that totally ultrasound-guided in complete supine PCNL had certain advantages, such as elimination of x-ray exposure to the surgeon and the operating room staff, avoidance of contrast media administration, identification of all the tissues between the skin and kidney, and no need to wear a lead shield. Ultrasound-guided PCNL in the supine position is recommended because of being safe and feasible even in re-operative patients.[13]

Basiri and colleagues in 2009 reported that the efficacy of PCNL with ultrasonography in the supine position was comparable to PCNL in the prone position with fluoroscopy. They suggested that it may be possible for expert surgeons to extend this approach to simple stones in patients with little operation risk.[14] The outcomes of ultrasonic access were similar to fluoroscopic access.[13,19,20]

Disadvantages

1) Sometimes the lubricant gel on the gloves can slide the dilators, which can be resolved by cleaning the hands.

2) The Amplatz dilator and Amplatz sheath echo do not have good imaging quality.

3) Less visibility of the guidewire echo causes the wrong way for the surgeon. It is possible to solve this problem by rigid Rouche guidewire.[8,13]

Computed Tomography (CT)

Although PCNL by the guidance of CT scan is feasible, it has numerous disadvantages, such as producing more x-ray, being expensive, and unavailable to be used in most operating rooms. Until now, there has been no report of using CT in the supine PCNL.

Blind Access

We believe that with popularity of imaging modality, especially ultrasonography, there is no place for blind PCNL. According to our knowledge, there is no report of using blind access in the supine PCNL.

Upper Pole Access in Supine PCNL

There is only one study about upper pole access in supine PCNL. The authors performed PCNL with a subcostal approach to the upper pole in 20 subjects. The mean operation time was 102.25 $\pm$ 41.56 minutes and the stone-free rate was 95%. The authors believed that in the supine position, the kidney is lower than the prone position; hence, the access to the upper pole is easier. Upper pole PCNL with a subcostal approach seems to be a new, valuable treatment option for complex stone disease.[8,15,18]

The Effect of BMI on the Results of Supine PCNL

Obesity may play a role in the efficacy of stone treatments, such as shockwave lithotripsy, and increase the risk of morbidity in the patients.[16,21-23] By several reported studies, BMI had no significant effect on the results of PCNL.[16,18,22,24,25] For proximal ureteral and kidney stones, PCNL is done in the supine position.[3,7,8,26] Supine PCNL is feasible in obese and morbidly obese patients; however, it may

increase the anesthesia time in patients with higher BMI.[8]

The effect of Previous Renal Surgery on PCNL

Previous renal surgery creates scar and fibrosis in the retroperitoneal space. On the other side, prescient infection and surgery would cause scar tissue in the cortex of the kidney. At first, physician may think these factors will affect the outcomes of PCNL in the patient with previous surgery, but some studies have repudiated the idea.[8,27-29] Percutaneous nephrolithotomy is feasible and safe in patients who have had previous renal surgery, but Falahatkar and colleagues reported that the fibrosis problem would be caused by the previous renal surgery and in the first step, the dilation process would be increased. They have considered the tone of the fascia as the key element of fibrosis problem. The authors have found no differences between outcomes of PCNL in two groups.[8,28]

There was only one study that compared supine PCNL in patients with and without a history of stone surgery. Eighty-one patients were divided into two groups. Renal surgery had been done in 28 (34.6%) patients (group 1) while 53 (65.4%) had no history of pervious renal surgery (group 2). They reported the outcomes of patients were similar in both groups.[10]

Tubeless PCNL

Nowadays, many researchers believe that the nephrostomy tube placement is not necessary after uncomplicated PCNL. However, the majority of urologists believe that there are few indications for nephrostomy placement, including severe hemorrhage, significant extravasation, and large stone residue.[3,7,10,13,15,18,30]

According to our knowledge, there is no study to compare patients with and without nephrostomy tube after supine PCNL, but there are several studies on tubeless supine PCNL without any major complications.[3,7,10,13,18] Falahatkar and associates have accomplished tubeless supine PCNL in 117 patients requiring complete supine PCNL and have demonstrated that it is a safe procedure with no significant complications.[7] We believe that tubeless PCNL is a safe and effective procedure in the supine position like the prone position.

CONCLUSION

The study showed that PCNL in the supine position is an effective and safe method for urinary stones. There are numerous advantages for PCNL, including decreasing operating time, evacuation of stone fragment, a more tolerable position for high-risk patients, and sitting position for the surgeon. We hope this paper encourage researchers in academic centers to perform PCNL in the supine position.

ACKNOWLEDEGMENTS

The supine PCNL study was supported and encouraged by Professor Simforoosh. It is a pleasure to thank all who made this research possible. We also show our gratitude to Mrs. Nadia Rastjou Herfeh for English revising.

CONFLICT OF INTEREST

None declared.

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