Supine Percutaneous Nephrolithotomy, Is It Really Effective?

A Systematic Review of Literature

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Introduction: This systematic review was performed to determine the clinical value of percutaneous nephrolithotomy in the supine position in comparison with the convention of performing the procedure in the prone position.

Materials and Methods: A systematic review of the medical literature was conducted searching for studies on percutaneous nephrolithotomy in the supine position, limited to publications appeared in the PubMed between 1980 and July 2008. Non-English articles were considered if deemed relevant by providing additional data. In the retrieved articles, reference lists were hand-searched to identify additional relevant articles.

Results: There were 9 original articles on percutaneous nephrolithotomy in the supine position. Five studies were retrospective and 4 were prospective, of which only 1 was a well-designed randomized controlled trial published in 2008. The success rate of the procedure was reported between 69.6% and 95%. The risk of requiring blood transfusion was between zero and 8%. Duration of hospital stay was variable, but generally less than that in the prone position. No colon perforation was reported.

Conclusion: In carefully selected patients with uncomplicated urinary calculi, percutaneous calculus removal in the supine position can yield similar outcomes to that in the prone position.

Keywords: kidney calculi, surgical procedures, percutaneous nephrostomy, methods, supine position, prone position

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INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is usually performed in the prone position. This approach, however, has some disadvantages; first, it compromises blood circulation and ventilation, especially in obese patients (limitation in respiratory movement).[1,2] Second, position changes during the procedure is inevitable, because preplacement of a ureteral catheter is commonly required in the dorsal lithotomy position before turning the patient to the prone position. These prolong duration of the procedure.[3] Third, if the procedure is carried out under spinal or epidural anesthesia, conversion to general anesthesia with endotracheal intubation will represent a great challenge to the anesthetist.[1,4] Fourth, sometimes it is impossible for the patient to lie prone because of body habitus such as ankylosing spondylitis, severe lordosis or kyphosis, or hip or lower limb contractures.[5] Fifth, operating on a patient in the prone position, the surgical team stands in close proximity to the patient, making them relatively more vulnerable to radiation exposure. Whereas

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in the supine position, the bodies and limbs of the surgical team remain outside the field of the fluoroscope.[4] Finally, the prone position is especially dangerous in patients with severe cervical spondylosis, and care of the pressure area is problematic.

To overcome these drawbacks and simplify the procedure, PCNL in the supine position has also been described.[1] This approach has also certain disadvantages that make it a disputable alternative. The first problem with the supine position is that there is not enough space for a third tract if needed.[6] Also, access to the anterior and upper calyxes is more difficult; as the angle between the plane of the operation table and the anterior calyxes is smaller than that in other positions, it is difficult to access the calculi in the anterior calyxes.[1,5,6] Approaching the upper calyx, especially if placed excessively medially is more difficult in supine position, as well.[4,7] This problems is more pronounced on the left side. Of other drawbacks of PCNL in the supine position is the mobility of kidneys which is more than that in the prone position. Therefore, the kidneys are easy to move anteromedially during tract dilation in the supine position.[1,4,6] Finally, the pyelocaliceal system is constantly collapsed in this position, and consequently, nephroscopy is more difficult.[7]

Some limited studies have tries to clarify the safety and efficacy of PCNL in the supine position; however, there is not consensus on its outcome, yet. The aim of this study was to review the published original articles on PCNL in the supine position, and to systematically analyze their reported results.

MATERIALS AND METHODS

We searched the PubMed for articles published between 1980 and July 2008 using the MeSH terms *percutaneous*, *nephrolithotomy*, *nephrolithotripsy*, and *supine*. The reference list of the retrieved articles was additionally studied to identify any relevant articles. Letters to editors or congress abstracts were excluded, and non-English articles were considered if deemed relevant by providing additional data.

Thereafter, we read all of the retrieved articles and designed a table to determine the study sample, study design, success rate, hospital stay, and reported complications of the studies. The results were compared, summed up, and discussed.

RESULTS

We found 9 published original articles on PCNL in the supine position,[1,4-10] the data of which are summarized in Tables 1 to 3. The overall number

Table 1. Studies on Supine Position in Percutaneous Nephrolithotomy*

Study	Publication Year	Sample Size		Study Design	Inclusion/Exclusion Criteria	Success Rate, %	Anesthesia
		Supine	Prone				
Valdivia Uria et al[10]	1998	557	…	Retrospective	Calculi, tumors, UPJOs	93	IS
Shoma et al[1]	2002	53	77	Clinical trial	All sizes of calculi	89	SA‖
Ng et al[7]	2004	62	…	Retrospective	All sizes of calculi	76	GA or high SA
Steele and Marshall[11]	2007	322	…	Clinical trial	All sizes of calculi	91	GA or high SA
Manohar et al[9]	2007	62	…	Retrospective	All sizes of calculi, high-risk patients†	95	GA and EA
Neto et al[8]	2007	88	…	Clinical trial	All sizes of calculi	70.5	Not mentioned
Zhou et al[6]	2008	92	…	Retrospective	All sizes of calculi	69.6‡	SA and EA
Rana et al[4]	2008	184	…	Retrospective	All sizes of calculi	84§	GA
De Sio et al[5]	2008	39	36	RCT	Multiple and staghorn calculi excluded	88.7	GA

*RCT indicates randomized controlled trial; UPJO, ureteropelvic junction obstruction; IS, intravenous sedation; SA, spinal anesthesia; GA, general anesthesia; and EA, epidural anesthesia. Ellipses indicate not applicable.
†Only patients with American Society of Anesthesiologists grades 3 and 4 were included.
‡Primary calculus clearance rate.
§Total calculus clearance rate.
‖Two cases were converted to general anesthesia.

of patients with PCNL in the supine position was 1459 in these studies. The technique of procedure was nearly similar; they put the patient in the supine position with a water bag below the ipsilateral flank. Thus, the flank was elevated up to 20 degrees, causing the posterior calyx to project more laterally, often becoming parallel (30 degrees) to the fluoroscopy table. A retrograde ureteral catheter was fixed through the ipsilateral ureteral orifice. The skin was punctured in the posterior axillary line, 1 cm below the last rib, for a lower caliceal puncture, and above the last rib, for an upper caliceal one. They used either C-arm fluoroscopy or ultrasonography for the first access and tract dilation.[3-11] The tract was dilated using balloon, plastic, or metal telescopic dilators (Table 2). The calculi were then fragmented and extracted. A 22-F nephrostomy tube was fixed at the end of the procedure in most studies.

The first report in this field belongs to Valdivia Uria and colleagues who performed more than 500 nephroscopies in the supine position. They included not only urinary calculi, but also ureteropelvic junction obstruction and ureteral tumors in their study. The aim of the study was to show possibility and safety of PCNL and the other procedures in the supine technique. Significant blood loss that required transfusion was reported only in 8 cases. The colon and the pleura were not damaged in any of the patients. They used intravenous sedation with diazepam, buprenorphine, atropine, and occasionally, ethinamate. The patients were conscious during the procedure.[10]

Shoma and coworkers compared the results of PCNL in the supine and prone positions. Their study was not randomized. However, the preoperative parameters of the two groups were comparable. The mean hospital stay, re-treatment rate, success rate, and complications

Table 2. Operative Data of Studies on Supine Position in Percutaneous Nephrolithotomy*

Study	Mean Hospital Stay, d	Operative Time, min	Double-J Catheter Insertion	Intraoperative Imaging	lithotripter	Dilator
Valdivia Uria et al[10]	…	15 to 240	…	Fluoroscopy	…	Alken
Shoma et al[1]	2.5	…	2 cases with leak	Fluoroscopy	Pneumatic ultrasound	Plastic telescopic
Ng et al[7]	8.7	…	…	US and Fluoroscopy	Pneumatic	Metal telescopic
Steele and Marshall[11]	6†	15 to 300	Usually	Fluoroscopy	Pneumatic holmium	Balloon
Manohar et al[9]	…	20 to 250	All patients	US and Fluoroscopy	…	Alken
Neto et al[8]	5.4	60 to 300	If residual is significant	Fluoroscopy	Pneumatic ultrasound	Metal
Zhou et al[6]	…	45 to 350	All patients	US	Pneumatic holmium	Telescopic (up to 16 F)
Rana et al[4]	2	45 to 110	10% of patients	Fluoroscopy	pneumatic	Alken
De Sio et al[5]	4.3	25 to 120	…	Fluoroscopy	ultrasound	Alken

*Ellipses indicate not available. US indicates ultrasonography.
†Six days with double-J catheter and 3 days without double-J catheter.

Table 3. Complications of Supine Position in Percutaneous Nephrolithotomy*

Study	Transfusion Rate, %	Embolization, %	Pleural Injury, %
Valdivia Uria et al[10]	1.4	0.5†	0
Shoma et al[1]	9.4	…	0
Ng et al[7]	3.2	0	0
Steele and Marshall[11]	3.7	0.3	0
Manohar et al[9]	3.2	0	0
Neto et al[8]	7.9	2.3	0
Zhou et al[6]	1.0	…	0
Rana et al[4]	3.8	…	0.5
De Sio et al[5]	0	0	0

*Ellipses indicate not available.
†One patient underwent open hemostasis; 1, nephrectomy; and 1, embolization.

were not significantly different between the two groups. It is important to note that they had only 3 staghorn calculi in each group.[1] Zhou and colleagues evaluated the clinical value of the real-time ultrasonography-guided minimally invasive PCNL technique in the supine position. It is one of the studies that used ultrasonography to access the system.[6] De Sio and associates published a well-designed, randomized controlled trial that compared the supine and prone positions. Transfusion rate and other complications were similar, but the operative time was significantly shorter in the supine position.[5] Colon injury was not reported in any of the reviewed studies.

DISCUSSION

Percutaneous nephrolithotomy is traditionally performed in the prone position for a safe approach to the kidney. Nevertheless, acute bleeding requiring blood transfusion in 3% to 12%, delayed hemorrhage in less than 1%, and bowel perforation in 0.2% to 0.5% of the patients are the major concerns in this approach.[12-14] Moreover, the prone position has some inherent drawbacks which were discussed here earlier. As a consequence, modified supine PCNL positions were suggested to overcome such problems.[10] Some aspects and concerns about the supine position are discussed below based on the reviewed articles:

Colonic Injuries

There had been concerns that the supine approach may have put the colon at a higher risk of injury than the prone position. In all the published studies on 1459 cases, there was no colonic injury in patients treated in the supine position. The contemporary data regarding PCNL with the patient in the supine position has not yet reported a single incidence of injury to the colon.

Transfusion Rate

Valdivia Uria and coworkers[10] reported the rate of serious bleeding requiring transfusion to be about 1.5%. Ng and colleagues[7] reported a rate of 3%, and Shoma and colleagues[1] reported a rate of 9%, but attributed it to their learning curve. Rana and colleagues reported a rate of 3.8% for bleedings that required transfusion,[4] which was directly related to the calculus size, procedure duration, and creation of multiple tracts. In contrast to all assumptions, the risk of bleeding with the supine position must be less. Obstruction of the inferior vena cava during PCNL in the prone position and backflow of blood to the renal vein may explain why bleeding in the prone position is more likely than in the supine position.

Success Rate

Methods for assessment of stone-free rate varied between the reviewed studies. Nephroscopy, noncontrast computed tomography, plain radiography, and ultrasonography are all mentioned. It is clear that in this condition, it is impossible to compare the data. On the other hand, the size of calculi was variable, although the authors mentioned that they included calculi with all sizes, staghorn calculi were constituted a small percentage of the cases in most studies. Success rate is dependent on many factors; hence, only in prospective randomized studies, we can determine the efficacy of supine PCNL unquestionably.

In their randomized controlled study, De Sio and colleagues reported that the stone-free rate was good in both groups of PCNL in the spine and prone positions (88.7% versus 91.6%, respectively; $P = .12$).[5] Shoma and coworkers,[1] in the only prospective nonrandomized study published so far, reported similar results for the supine and prone positions (89% versus 84%, respectively). However, we should consider some limitations in the supine position as well; it is obvious that lateral deflection of the rigid nephroscope into an anterior calyx is difficult because of the side of the bed. Then, it is predictable to use flexible nephroscope for this position more often than that for the prone position, and therefore, more limited vision and less success rate is anticipated. It means that the supine position should be used for highly selected patients.

Operative Time

The definition of operating time was different among the reviewed studies. De Sio and colleagues[5] defined it as the time from

ureteral catheterization to the placement of the nephrostomy tube; however, Rana and associates[4] calculated it from the anesthesia charts. In most of the studies, the operative time was not clearly defined, but it is obvious that the time of PCNL is dramatically lower in the supine position compared to that in the prone position. The only parameter that reached a statistical difference in De Sio and colleagues' randomized controlled trial was the operative time (43 minutes versus 68 minutes; $P < .001$).[5] The authors stated that this difference was attributed to turning the patient at the beginning and the end of PCNL in the prone position.

CONCLUSION

We conclude that supine PCNL is safe, and because of its advantages in high-risk patients, it is necessary that every endourologist increases his/her skills in this technique. However, the supine position is not a substitute for the prone position for PCNL. We need more prospective randomized studies in this field to draw an affirmative conclusion.

CONFLICT OF INTEREST

None declared.

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