



ORIGINAL RESEARCH PAPER

Urology

COMPREHENSIVE OVERVIEW AND ANALYSIS OF MODIFIED SUPINE PERCUTANEOUS RENAL PROCEDURES

KEY WORDS: Percutaneous nephrolithotomy, percutaneous nephrostomy, supine, endourology, stone.

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ABSTRACT

Introduction Since about 20% of PCNLs around the world are done in the supine position, many surgeons have learned PCNL from mentors who do it in the prone position. This is seen as a reason why the supine position for PCNL isn't used more often. Many surgeons would agree that it is possible to move a patient from the prone position to the supine position during a procedure with a high success rate. The purpose of this study is to provide a comprehensive review of supine percutaneous nephrolithotomy (PCNL) with illustrative advice for optimising its execution in full safety. Critical analysis of the pros and negatives of supine PCNL is performed so that the urologist can experience the beauty of this position and be prepared to overcome its minor drawbacks. **Objective:** To perform a prospective randomized trial studying the efficacy and safety of percutaneous renal procedures in modified supine position and to list out advantages and disadvantages of modified supine position. **Methods:** The study was conducted from January 2021 to December 2021, at Dr. D.Y Patil medical college, Hospital and Research Institute, Kolhapur. 40 patients with renal calculi and 20 patients with accompanying ureteral calculi (total 60 patients) were included for the study. Patients were randomized to undergo fluoroscopy, cystoscopy and PCNL, PCN procedures in the modified supine position. Baseline characteristics, operation time, stone free rate, loss of blood, hospital stay and second phase PCNL, PCN were observed. **Results:** According to a number of published research, it is usually assumed that prone and supine percutaneous renal operations have equivalent stone-free and complication rates. In the modified supine posture, the rate of second PCNL and PCN was much lower, and the rate of stone removal was higher. In the modified supine posture, the average duration of surgery was shorter (about 98 minutes) and the anaesthetic risk was reduced. There were less surgical problems and shorter hospital stays on average. **Conclusions:** In conclusion, the balance of positives and cons favours supine posture for PCNL, in our opinion. Experience accumulated over more than a decade of supine PCNL has enabled us to establish certain guidelines to facilitate the transition from prone to supine position, optimise its outcomes, and minimise the rate of problems.

INTRODUCTION

In 1976, Fernstrom and Johansson initially described percutaneous nephrolithotomy (PCNL) in prone position^[1]. Since then, this surgical technique has become the gold standard for the treatment of big stones, and it has progressed, resulting in a reduction in invasiveness and morbidity, as well as improvements in ergonomics and results. Initially, PCNL was conducted in the prone position since it was believed that other positions increased the risk of colon injury during percutaneous kidney puncture. Considering that intravenous pyelography was the gold standard for imaging stone disease in the early days of PCNLs and that modern cross-sectional imaging techniques like ultrasound and computed tomography (CT) were not commonly used, early PCNL surgeons lacked the peri-renal anatomy knowledge that is readily available to the modern urologist. Valdivia Ura thought in 1987 that PCNL could be done in a position called "supine decubitus." Using pre-operative CT scans to evaluate the patients, he showed that PCNL done in the supine decubitus position has similar outcomes and complications, with possible ergonomic and anaesthetic advantages^[2,3]. Also, later CT studies of the relationship between the organs around the kidney and the kidney have shown that the risk of colon perforation, the problem that caused early PCNL to be done in the prone position, is actually lower in the supine position, with the rate of retro-renal colon position being 1.9% in the supine position and 10% in the prone position^[4], putting to rest the idea that you are more likely to hurt your colon when you sup. Even though prone PCNL is still the most common, supine PCNL is on the rise. In

the Global PCNL study of the Clinical Research Office of the Endourological Society, 20% of all PCNLs were done in the supine position^[5]. This article examines various techniques for percutaneous renal access in the supine position, focusing on changes in patient positioning and puncture technique. From the Valdivia position to the Valdivia-Galdakao position to the Giusti position, a patient's posture changes. Marking on the patient's skin the lower edge of the 12th rib, the iliac crest, and the posterior axillary line helps the surgeon keep track of where they are once the patient is draped.

We usually place the patient five centimetres away from the radiopaque edge of the operating table so that the fluoroscopic examination of the kidney and puncture tract is not affected. In some centres, newer radiolucent carbon tables designed for endourological procedures don't have this radio-opaque edge.

This means that patients can be placed closer to the edge of the bed, which may make it easier to move the nephroscope and less likely that it will hit the bed when the nephroscope is used at wider angles. Lastly, the best table should be able to be moved at the bottom so that the C-arm can be used to look at the whole genitourinary tract.

If the standard bed doesn't meet this need, you could flip it over or add a Mayo table to hold the patient's feet. Valdivia's original description of supine PCNL includes the placing of a 3-liter saline bag under the patient's flank to enhance exposure to the puncture site (2). (Figure 1). Different

variations of positioning, including lateral^[6], total supine^[7], and modified supine^[8], have been documented over the past decade.

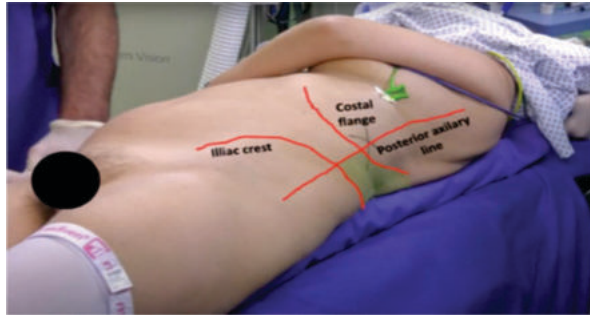


Figure 1
Valdivia's position.

The most popular posture is the Galdakao-modified Valdivia position^[8], which is a modification of the supine Valdivia position. To permit simultaneous percutaneous antegrade, ureteroscopic, and retrograde transurethral access to the urinary system, the legs of the patient are inserted in a modified lithotomy position with both legs in stirrups.

We have recently developed a modification to the Galdakao-Valdivia posture in order to overcome potential restrictions in nephroscope manoeuvrability caused by the nephroscope pushing against the stirrup support^[9], particularly when attempting to reach the higher pole from a lower pole access. These alterations are referred to as "Giusti's posture" and are seen in Figure 2: The patient is positioned near the table's lateral edge, and the flank is gently lifted using a small bolster to achieve a gentle rotation of 15–20 degrees. To allow for cephalad-free tilting of the C-arm during puncture, the ipsilateral arm is positioned across the thorax while avoiding any strain of the brachial plexus. The PCNL leg is left straight on half of the operating table without a stirrup, and a single stirrup is used to support the contralateral leg so that a second surgeon can conduct retrograde transurethral ureteroscopy at the same time.



Figure 2
Giusti's position.

RESULTS

In Table 1 we present the patients' initial characteristics. Basic characteristics of patients who underwent percutaneous renal procedures in modified supine position. Puncture route in patients who underwent percutaneous renal procedures in modified supine positions.

Table 1

	Modified supine group
Total patients	60
M/F ratio	36:24
Mean age, yr (SD)	49.8(11.79)
BMI	18.6-26.2
Renal/Ureter	40:20
Mean stone size, (range)	3.3(2-6)
Hydronephrosis yes/no	32
Previous medical and surgical history(n%)	21(35%)

Table 2.

	Modified supine group
Flank puncture	
Above posterior axillary line, n(%)	9 (15%)
Below posterior axillary line, n(%)	51 (85%)
Calyx puncture	
Lower, n(%)	28 (46.67%)
Middle, n(%)	22 (36.67%)
Upper, n(%)	10 (16.66%)
Puncture times	
<3	52 (86.67%)
≥3	8 (13.33%)

Table 3.

	Modified supine group
Operative time, min(range)	98.7 +/- 13.96
Stone free rate, n(%)	(89%)
Stone recurrence rate, n(%)	3(5%)
Use of analgesics, n(%)	15(25%)
Mean hospital stay, d(range)	4.77 +/- 1.04
Stage II PCNL, n(%)	2(3.33%)
Major complications, n(%)	0
Minor complications, n(%)	10(16.67%)
Transient fever n(%)	6(10%)
Clinically insignificant bleeding n(%)	3(5%)
Renal colic n(%)	1(1.67%)
Mean blood loss(ΔHb),g/dl	-2.4(3.6-0.4)
Need of post op ICU	0
Need of blood transfusion, n	0
Positional Discomfort	0

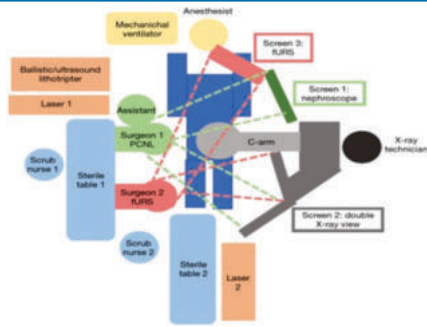
Table 2. depicts the puncture pathways. We initially chose the subcostal area for rib puncture; however, when the subcostal area could not reach the appropriate target calyx, an intercostal puncture was performed. The lower calyx was the most frequently punctured target calyx. The majority of patients were punctured no more than three times. **Table 3** displays intraoperative and postoperative parameters. The mean operation time was significantly less 98 min and the stone free rate was high (89%) in the modified supine. The rate of repeat PCNL was less in modified supine position. Few patients experienced stone recurrence after primary and second-look surgery, and no patient experienced major complications. There were not many patients in the post-op ICU who needed painkillers, stayed in the hospital for an average amount of time, had high hospital bills (data not shown), got medicine therapy, lost an average amount of blood or needed a blood transfusion.

DISCUSSION

The prone position has traditionally been utilised for percutaneous renal operations, and it is currently the most common. But over the last ten years, various adjustments to patient posture for PCNL/PCN have been suggested. In 1998, Valdivia described the first supine posture, which included a 3-L saline bag beneath the flank.

The Galdakao modified Valdivia position, which rotates the supine orientation of the contralateral leg into flexion and the ipsilateral leg into extension, was another modification made to this position in 2006. 2008 saw the first description of the Barts modified Valdivia position, which creates a bigger surface area for simple access by adjusting the nephroscope.^[10] According to studies, urolithiasis is more common in men and women between the ages of 40 and 49 and 30 to 39, respectively.

One of the often used methods for treating urolithiasis in individuals with chronic kidney disease who have big renal stones—stones greater than 20 mm²—staghorn and partial staghorn calculi, and stones—is PCNL^[11].



Prone ECIRS operating room setting. Surgeon 1 performs PCNL and surgeon 2 performs FURS. ECIRS, (endoscopic combined intrarenal surgery); PCNL, (percutaneous nephrolithotomy); furs, flexible uretero-rensoscopy

Positives and negatives of the supine posture

Positives-

Improvements in anaesthetic management

Supine position for PCNL offers some advantages over prone position for PCNL in terms of anaesthesiologist management, such as the following: less risk of injury to central and peripheral nervous system (e.g., vascular, peripheral nerve and cervical spine injuries, tracheal compression and ocular damage) associated with prolonged prone anaesthesia, less risk of thromboembolism due to the absence of inferior vena cava compression, and improved ventilator-associated pneumonia. Lastly, fluid absorption is reduced in the supine position; this is especially essential for patients with poor cardiovascular state^[12] and those at risk for systemic infection due to struvite or non-struvite stones colonised by bacteria.

The danger of single-lung breathing increases if the endotracheal tube becomes dislodged during the patient's shift from the supine to prone position. Supine PCNL eliminates the possibility of this pulmonary consequence. Additionally, there is no need for additional anaesthesiologic equipment, such as stronger endotracheal tubes, stabilising helmets, or particular paddings, which could increase the treatment's cost.^[13]

Alterations to patient posture and a reduction in operative time

Supine PCNL reduces the workload of operating room (OR) personnel because the patient is not need to be repositioned following ureteral catheter placement, as is the case with typical prone PCNL. For supine PCNL, a single drape and position are utilised for the duration of the treatment. This advantage is considerably more noticeable in obese people. Several investigations have demonstrated that the absence of repositioning the patient following induction of general anaesthesia or after placement of the ureteral catheter results in a shorter total operation time for supine PCNL compared to prone PCNL.^[14]

Decreased intrarenal pressures

In supine position, the renal sheath angle is normally parallel to the floor or slanted downwards toward the floor. This is the reverse of the position of the renal sheath during prone PCNL, in which the sheath is oriented toward the ceiling (i.e., away from the floor). Therefore, the angulation of the renal sheath during supine PCNL increases the outflow of fluids and stone particles from the kidney. This persistent spontaneous evacuation of fluid from the renal pelvis in the supine position may minimise renal pelvis pressures and, theoretically, the risk of infection following PCNL. [15] In the supine position, it may be more difficult to distend the collecting system, demanding greater quantities of fluid irrigation than an efficient endoscopic inspection of the collecting system.

Decreased radiation exposure and improved ergonomics of fluoroscopy

Because the surgeon's hands are not immediately under the X-ray beam during supine PCNL, radiation exposure to the surgeon is reduced. This is in contrast to prone PCNL, in which the surgeon's hands are substantially more likely to enter the radiation field when using traditional prone access procedures such as triangulated or bull's-eye guided puncture. However, no comparative statistics have been provided as of yet. By placing the patient in a more lateral skin position for renal puncture when supine, the C-arm is less likely to "bumper into the nephroscope" or "displace the nephroscope" during surgery, allowing for a more comprehensive evaluation of the kidney. Furthermore, unlike when performing prone PCNL, the surgeon is able to sit comfortably during the procedure, sparing his or her back the strain of long periods of uncomfortable standing over supine patients.^[12]

Negatives -

Mobility of the kidney –

One of the most significant disadvantages of supine posture is that the kidney is frequently more mobile in the supine position than in the prone position (figure 3). (figure 3). Some patients, particularly those with a body mass index (BMI) of less than 25 kg/m², exhibit kidney movement after percutaneous puncture and subsequent dilation. In the prone position, when the kidney is locked by the weight and rigidity of the posterior abdominal wall against the operating table, this motion is significantly reduced.

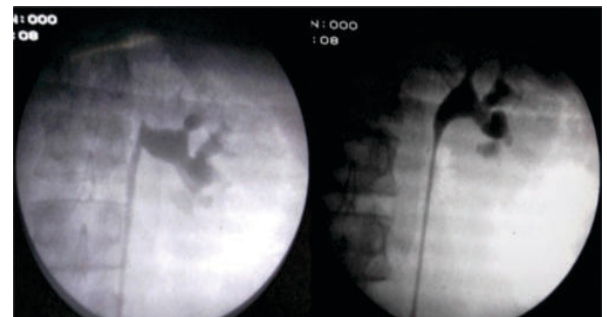


Figure 3
Kidney hypermobility in supine PCNL. PCNL, percutaneous nephrolithotomy.

During supine puncture, the following approaches can be utilised to stabilise the kidney and limit its mobility: abdominal compression by the surgeon or helper, "through-and-through" placement of the guide wire (i.e., pass the guidewire into the bladder, then retrieve this with a cystoscope so that there is through-and-through access). Also a ureteral access sheath can be placed in a retrograde manner and the calibre of the renal access sheath can also be decreased—the smaller sheaths (such as mini PC)

Longer percutaneous tract

In the supine position, percutaneous puncture is administered from a more lateral location on the patient's flank than in the prone position; this may increase the tract length in patients receiving supine PCNL compared to prone PCNL. In contrast, the length of the tract is typically shorter during prone PCNL. This may be partially because the front abdominal wall is more flexible than the posterior abdominal wall. In the prone position, the more flexible anterior abdominal wall transmits pressure from the bed to the kidneys, restricting the kidneys' movement and shortening the percutaneous tract.^[17]

Consequently, the point at which the renal access sheath enters the kidney functions as a pivot. The more away this fulcrum is from the skin, the less manoeuvrable the distal end of the sheath will be within the collecting system (for example, if the access tract is longer). These limitations can be overcome by routinely use a flexible nephroscope during supine PCNL.

Anaesthetic considerations-

The prone position poses a challenging obstacle for the anaesthesiologist. When putting a patient in the prone position, it is important to evaluate the possibility for major circulatory alterations. Due to decreased venous return, lower left ventricular compliance as a result of higher thoracic pressure, and direct impacts on arterial filling, the patient's cardiac index is diminished in the prone position. Known consequences of the prone posture include decreased cardiac output, venous stasis, and thromboembolic events. In addition, the prone posture is associated with restricted respiratory mobility, which has implications for obese people and those with respiratory disorders. Despite this, a number of studies have shown an increase in functional residual capacity in the prone position for both healthy and obese patients^[18]. The anaesthesiologist must also pay close attention to the position of the endotracheal tube as the patient assumes the prone position. Endotracheal tubes are susceptible to kinking and displacement when moving. Additionally, the prone position can be problematic for patients having loco regional anaesthesia. If perioperative conversion to general anaesthesia is required, airway access can be challenging. The supine position poses less of an anaesthetic challenge because the cardiovascular alterations observed in the prone position are avoided and the airway can be accessed quickly and easily.^[18] No subjects in our research had significant problems.

CONCLUSION

Both the prone and modified supine positions are safe and effective for renal percutaneous procedures. Supine posture may be related with a lower incidence of serious complications. Given the advantages of the modified supine position for the surgical and anaesthetic teams, particularly with obese patients, the modified supine position is recommended. Slightly better results in SFR in prone (89%) with less operative time. Less gastrointestinal issues as compared to prone posture. Superior for many lower pole stones, obese and high-risk patients, ectopic pelvic and transplanted kidneys.

In conclusion, we believe that the balance of positives and negatives favours the supine position for PCNL. Experience accumulated over more than a decade of supine PCNL allowed us to establish certain guidelines to facilitate the transition from prone to supine position, maximise its outcomes, and reduce the risk of problems.

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