

Supine PCNL (sPCNL): Challenging the “Standard” Prone (pPCNL)

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Recently, the global endourology scene has witnessed a resurgence of interest in supine PCNL (sPCNL). The number of urologists who are attracted to this “simplified method” of PCNL is growing and its promoters are suggesting to abandon the standard prone approach. Debates on the two positions have become commonplace in endourology scientific meetings. The advocates consistently emphasize that when compared to the prone position, sPCNL has multiple advantages for the surgeon, the anesthesia team and the patient. In spite of these, it is evident that many still favor prone PCNL (pPCNL) because of its time-tested proven efficacy and safety. In fact, up to this present day, majority of PCNLs are still done in the prone position. This review article intends to analyze the “current state of affairs” of the two PCNL positions, describing their advantages and disadvantages. Presently, applying the principles of “what is safe and efficacious in one’s hands” dictates the choice of which technique is utilized to treat a patient. Conversely, it is more clinically sound if this choice was made instead, in consideration of, the interplay of the following factors such as the patient’s clinical demographics, the anatomical features of the renal collecting system, the stone burden and characteristics and ultimately, the physician’s training, skills and experience.

Keywords: Percutaneous nephrolithotomy (PCNL), positions, outcomes

Introduction

Since the first percutaneous stone extraction by Fernstrom and Johansson in 1976,¹ percutaneous nephrolithotomy (PCNL) has gradually emerged as the new standard for large volume renal stones >2cm. It is also recommended for smaller stones which failed therapy with extracorporeal shock wave lithotripsy (ESWL) and retrograde intrarenal surgery (RIRS), or are poor candidates for these two modalities. Despite its widespread application however, there is yet no singular standardized method for performing PCNL. Such variability in the available techniques can be seen throughout several aspects of the procedure such

as the surgical position, type of image-guidance used for percutaneous renal access, the instruments used for renal tract dilation, the size, location and number of access sites, the energy-device used for lithotripsy and different options for postoperative drainage. The determination of the most optimal PCNL technique remains elusive. More recently, discussions have focused on the “paradigm shift” from prone to supine PCNL positions, suggesting that the “time-tested” and “standard” prone PCNL (pPCNL) ought to be abandoned. Is there justification in such a proposal?

The primary endpoints of any endoscopic stone management include a high efficiency (stone-free rate, operative time, length of hospital stay) and

safety (transfusion requirement, infection rate, renal or visceral organ injury): two-fold goals that are also non-negotiable in any type of operative procedure. The author intends to analyze these two methods according to these endpoints.

Landmark Studies of Valdivia: Rationale for the Supine Position

During the first decade of PCNL, the procedure was done exclusively prone. It gained general acceptance because of its proven efficacy and safety.^{2,3} Valdivia Uria and associates later introduced the first supine PCNL (sPCNL) in 1987.⁴ This was done after a careful study of corpses and images obtained from computerized tomography (CT scan) demonstrating that it is safe to do a percutaneous renal access in the supine position without an increased risk for colonic injury, which was the predominant concern among urologists who preferred doing the PCNL in the prone position.

A decade later, his team completed >500 cases of supine percutaneous nephroscopy for renal stones and other indications.^{5,6} He described his “simplified version of PCNL,” which was done using a combination of local anesthesia and intravenous sedation, as having similar risks to prone, while making it possible to operate in a way that is “easier for the surgeon and more comfortable for the patient.” In this supine position, the surgeon had the option to be seated or standing according to their preference, although in most instances, seated during nephroscopy. The access needle was advanced through the flank perpendicular to the cone of the fluoroscope without interposing the hands, thus reducing radiation exposure to the surgeon during the procedure. The entry of the needle through the renal capsule was also easily observed because it deformed the papillae of the calyx prior to the final entry (not really a unique characteristic of the supine approach). Cases may be done under sedation and local anesthesia in contrast with pPCNL, which were usually managed with general endotracheal anesthesia. Airway management was easier as it was less predisposed to accidental endotracheal tube dislodgment.

Many believed that the supine position provided a novel solution to contraindications to the prone position, due to circulatory and ventilatory

difficulties, especially in obese patients. While this may seem logical, this clearly was not the main intention of Valdivia. Contraindications such as severe cardiopulmonary disease, skeletal deformities or morbid obesity constituted only a minority of his subjects in the initial experience. Only 65 (12%) high-risk patients (ASA>III) were included and successfully treated with local anesthesia only. There were only 7/557 (1.2%) morbidly obese patients weighing more than 100kg, thereby constituting only a smaller part of the patient population.

The complication rate from this early series of sPCNL was low (<1%) but there were three cases of serious postoperative hemorrhage which were treated with angioembolization, open hemostasis and nephrectomy, respectively. There was no hydrothorax, pneumothorax or colonic injury and the pain scores were generally low. These complications were comparable and not significantly higher compared to previous studies on the early experience of pPCNL.^{2,3}

There were other advantages cited by the authors such as the downward slope of the PCNL access (Amplatz) sheath which allows passive drainage of irrigation fluid together with the stone fragments by gravitational pull. This position also permitted simultaneous ureteroscopic access when necessary in the management of complex renal stones, because of quick access to the perineum.

CROES PCNL Study

The Clinical Research Office of the Endourological Society (CROES) gathered data for consecutive patients who were treated with PCNL at centers around the world for one year. This largest prospective database collection involving around 5,800 patients around the world, showed that PCNL is highly efficient (30-day stone-free rates >76%) and safe (complication rates < 8%).⁷ A subset analysis using the same data was also done comparing position-related outcomes between pPCNL and sPCNL.⁸ A total of 5775 patients had available data related to the surgical position. It is evident the most cases were done in prone (80.3%) vs. supine (19.7%) emphasizing that the previous is indeed favored by many throughout the world. The operative time was shorter for the pPCNL (90.1 vs 82.7 min; $p < 0.0001$), a startling contrast to the presumption

that the time needed to complete sPCNL would be shorter because repositioning was not needed. The stone-free rates were significantly higher in the pPCNL (77%) compared to sPCNL (70%) and this was neither affected by the mean stone size nor by the number of staghorn or non-staghorn calculi treated with either method.

Systematic review and Meta-analyses Comparing sPCNL vs. pPCNL

Yuan, et al.⁹ recently performed a systematic analysis of 13 studies (6 randomized controlled trials and 7 retrospective studies) consisting a total of 6881 patients (1703 vs. 5178 in the supine and prone, respectively). The stone-free rate was significantly higher in the pPCNL: 77.7% (4025/5178) than the sPCNL: 74.3% (1266/1703). However, the supine position had shorter mean operative times and lower incidence of blood transfusions. There was no significant difference in the length of hospital stay. The over-all complication rates were similar for both groups except for fever rates which were lower in the sPCNL.

Wu, et al.¹⁰ also did a meta-analysis of several reports inclusive of 4 clinical comparative and 27 case series studies. Of the four comparative studies, there were two randomized controlled trails (RCTs), a prospective non-randomized and a retrospective non-randomized study together involving 182 sPCNL and 207 pPCNL cases. Results showed that RCTs with equivalent stone burden had similar stone-free rates between the pPCNL and the sPCNL (82.4% vs. 82.1%). However, the operative time was shorter in favor of sPCNL (65±15 vs. 90±15 min, $p = 0.0009$). The postoperative transfusion rate and mean length of hospital stay were however similar. There was 1/182 (0.005%) renal units of sPCNL who sustained a colonic injury. There were no pleural injuries in both positions. However, analysis of the included case series showed variable stone burden between the two groups, where a larger proportion of staghorn and multiple calculi were treated in the prone position (45.8% vs. 31.7%). There were also more cases of pPCNL (3,888 renal units) compared to sPCNL (949 renal units) with stone-free rates of 83.5% and 84.9% respectively, although this did not reach statistical significance ($p = 0.271$). These findings seem to suggest that surgeons are likely to

approach large staghorn calculi in the prone because of easier access to the upper pole, and additional calyceal punctures as needed for better stone clearance rate. For this reason, the transfusion rate in the case series was slightly higher in the pPCNL (4.5%) compared to sPCNL (2.7%) and this reached statistical significance ($p = 0.002$).

Liu, et al.¹¹ also performed a systematic review comparing the two different positions. Inclusive of two randomized controlled trials and two case-control studies. The stone-free rates were similar in both groups of pPCNL and sPCNL (83.5% and 81.6% respectively). However, sPCNL had shorter operative times. Both techniques had equivalence as regards complication, transfusion, and fever rate.

Guisti, et al.¹² recently performed a prospective randomized clinical trial of supine and prone PCNLs with particular focus on their “Double-S” (supine) position which they had previously described. This involved a total of 90 patients over a period of 17 months randomized to the two positions. A sub-analysis was done on patients that were treated purely antegradely (Trial A) and another group which was treated with endoscopically-combined intrarenal surgery (ECIRS) (Trial B), in both positions. They found that their method had the same efficacy and safety as the standard prone technique. They also emphasized that the operative time which was shorter in favor of the supine group, and could easily be reduced through the help of a professional team of nurses. However, the readers should be aware that given the authors’ preference for the supine position, operator and investigator biases are inherent to the study.

There is very minimal argument that low volume stones could be cleared with the same efficiency using both positions of PCNL. However, the question of whether this could be achieved in a similar fashion for complex and large volume stones, such as staghorn remains. Therefore, Vincentini, et al.¹³ studied the impact of the two opposing positions of PCNL on the outcomes of PCNL for high volume and complex renal stones, which were classified as GSS 3 or 4, based on the Guy Stone classification. For a period of three years, prospective data collection was done on 240 consecutive patients with GSS 3-4 underwent PCNL. Interestingly in this series though, 21.2% were prone and 79.8% were supine. Both groups were described to be comparable, although intercostal

access was more common in prone cases (25.5% vs 10.5%; $p=0.01$). The success rates, complications, blood transfusions and surgical times were similar for both groups; however, there were significantly more visceral injuries (10.3% vs 2.6%; $p=0.046$) and sepsis (7.8% vs 2.1%; $p=0.042$) in prone cases. These findings however, are based on unequal group and therefore, the conclusions remain in question.

Advantages of Prone PCNL

The standard pPCNL has several established advantages: a wide and limitless operative field and unrestricted nephroscope navigation. One of the most important and undeniable advantage of the pPCNL is easy and direct access to the upper pole posterior calyx, where a transpapillary entry is easiest achieved (via a bullseye technique) because of the posterior and medial orientation of this apical calyx.¹⁴ The supine position cannot gain access to this calyx in a similar trajectory because of the inherent limitation that the position gives, even in the Barts flank-free, Galdakao-modified Valdivia position. In the sPCNL, the entry to any calyx is almost perpendicular, given the narrow window for percutaneous puncture, thereby risking an infundibular injury.

Valdivia Uria claimed that “Once the nephroscope is placed into the kidney the probability of completing the procedure is similar for both positions.” This is not necessarily so. The medial and apical location of the upper posterior calyx makes it inaccessible through sPCNL, unless a renal displacement is done. Even if it was possible to enter the apical calyx while supine, the entry of the needle is typically posterolateral, which makes it less ideal as a single main access site. There is also excessive torque placed on the nephroscope when the upper calyx is entered in the supine position which obviates the advantages that are typically seen when this calyx is entered through the prone position.

Vande Lune, et al.¹⁴ was able to demonstrate that when an upper pole prone access is utilized for a staghorn calculus, the need for additional punctures is minimized because the view from the apex is a straight line to the lower pole and the ureteropelvic junction, which provides an instant panoramic view of the collecting system. This is because the upper pole entry is coaxial to the axis of ureter, thus

minimal manipulation is necessary to visualize these areas. Similarly, minimal torqueing is also needed to gain access to the rest of the kidney, even the middle calyx which is typically at right angles with the upper calyx. Because of this, complete clearance may be achieved through only one access. Difficult to reach calyces are easily reached and made possible with the addition of a flexible nephroscope. This was clearly demonstrated by Wong, et al.¹⁵ In this study, the stone-free rate with a single upper pole access, utilizing flexible fluoroscopy in conjunction with Holmium laser lithotripsy, the stone-free rate was 93%.

Certainly, one could always argue that a flexible nephroscope could also be applied through a single mid-polar access or lower calyx in sPCNL in order to navigate all calyces. However, rigid nephroscopy alone may often be all that is needed through a single upper pole pPCNL to achieve the same goals. The co-axial orientation of the upper pole access pPCNL, however also provides easier and more intuitive passage of the guidewire into the ureter, all the way into the urinary bladder, which stabilizes the access throughout the entire procedure. In the supine, the ureter is almost always at an acute angle with the percutaneous entry.

The other superior advantages of the pPCNL is also well-defined in the study of Carrion, et al.¹⁶ Even though the supine position is seen as safe and efficacious as the prone position, this approach has some disadvantages; for instance, collapse of the collecting system, difficulty in nephroscopy and in approaching the upper calyx, and small surgical field for nephroscopy. In contrast, hydrodistention in pPCNL allows the surgeon to see large stones more effectively, are less likely to require a secondary puncture for complete stone clearance. Nonetheless, when multiple tracts become necessary, it is also easier to add additional access sites because of the wide operative field. It also gives additional benefits of easy access to the contralateral operative field, and provides an opportunity for bilateral synchronous PCNL procedures.

The proponent of sPCNL claim that one of the advantages of their approach is a combined antegrade and retrograde access ECIRS may be performed simultaneously because of immediate access to the perineum. The same concept has been done years ago, in prone ECIRS and was made possible with the

split-leg table and flexible endoscopes. More recently, a comparative study of supine and prone-split leg position was done by Batagello, et al.¹⁷ showing that in either position, ECIRS is efficient and safe with comparable complication rates.

Repositioning-related musculoskeletal and ocular injuries are mentioned in arguments against pPCNL. However, an extensive search of literature did not show any such complications occurring in PCNL. They are either under reported or may not occur at all. The shortcomings observed in the supine technique such as a restricted working space, difficulty in performing upper pole puncture, and obstinate rigid nephroscope manipulation requiring in several cases, complementary use of the flexible nephroscopy, have limited its universal adoption. Since the surgeon is more focused on his primary endpoint which is stone clearance and ease of operation, these so-called “dreaded complications” related to re-positioning have not thwarted the surgeons from shifting to supine.

Should We Abandon Prone PCNL

As early as 1990s, Valdivia raised the question “Why is percutaneous nephroscopy still performed with the patient prone?” In his early series, he claimed equivalence of sPCNL to pPCNL stating that his technique is a simplified version that benefits the surgeon, the anesthetist and the patient. As more endourologists adopted the sPCNL technique worldwide, the statement: “Prone was a mistake” later became a Machiavellian expression, echoed in many debates and urology discussions. The #pronexit was coined in social media platforms and “*exclusively-supine*” PCNL was a terminology adopted by many large volume centers doing sPCNL, thus, questioning the necessity of learning pPCNL as a mandatory prerequisite among the skill sets in endourology.

In the above discussion, there are multiple studies favoring either position, and others which showed clinical equivalence abound. Surgeons performing PCNL must bear in mind that each of these positions will have inherent advantages and disadvantages.

There is no doubt that when there are contraindications to the prone position, the patients will be best treated in the supine position. However, such arguments may not be applicable

to normal healthy individuals who do not have such a contraindication. Other features should be considered most especially the stone burden and renal anatomical features. Patients with large or even full staghorn may benefit the most from a prone approach where the upper posterior calyx is more accessible, there is a wider space for multi-tract approach and even a combined antegrade and retrograde approach.

Conclusion

The search for the best and most ideal technique for PCNL remains elusive. This is as true for the search of the superlative and simplest position for performing the same. In order to understand what works best for patients, the surgeon has the duty to learn the various techniques while comparing their attributes objectively. He should then correlate his knowledge and experience with his clinical assessment and ultimately, choose what is most efficient and safest in every case.

Disclaimer:

Dr. Jose Benito A. Abraham is a fellowship-trained endourologist from the University of California, Irvine Medical Center under the direct supervision of Dr. Ralph V. Clayman. He introduced and popularized the widespread use of upper pole access PCNL in the Philippines and has currently completed more than 800 cases. His technique is considered by many as the preferred first choice when performing PCNL for all types of renal stones. Recently, he was attracted to supine PCNL and started to incorporate it into his clinical practice. He is also the proponent of bilateral synchronous upper pole prone-PCNL in the Philippines and continues to practice this as a viable option for bilateral stone disease. His other interests include multi-tract PCNL, mini-PCNL and tubeless PCNL and RIRS.

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