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Supine versus prone percutaneous nephrolithotomy for renal calculi: Our experience

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Abstract

Objectives: To compare operative times, safety, and effectiveness of percutaneous nephrolithotomy in the supine versus the prone position.

Materials and methods: An observational study of 100 patients was conducted in our institution for 2 years from 2018 to 2020 divided into 2 groups: 50 patients underwent modified supine percutaneous nephrolithotomy (PCNL) and 50 patients underwent standard prone PCNL. The inclusion criteria included a renal calculus (calyx or pelvis) of any size for which PCNL was indicated and exclusion criteria were patients having contraindications for PCNL such as bleeding disorders, pregnancy, high risk, and co-morbid conditions. The measured data included operative time, number of punctures, stone-free rate, length of hospital stays, and rate of complications.

Results: The 2 groups were comparable in mean age, male to female ratio, calculus size, number of punctures, residual calculi, and postoperative fever and pain. The mean difference of hemoglobin in the supine PCNL group was 0.37 g/dL whereas in the prone PCNL group it was 0.61 g/dL. The p value was significant at 0.043. The mean time to finish from initial postion was 72.24 minutes in supine PCNL and 88.12 minutes in prone PCNL. The p value was significant ($p < 0.001$). The mean time before puncture was 20.92 minutes in the supine position and 31.84 minutes in the prone position. The p value was significant ($p < 0.001$). The mean time from puncture to finish was 51.32 minutes in the supine position and 56.28 minutes in the prone position. The p value was significant ($p < 0.001$).

Conclusions: As observed from this study, supine PCNL is associated with a significantly reduced operating time when compared to conventional prone position PCNL procedures. The postoperative complications such as pain and fever were not significantly different. Hence, the supine PCNL is an equally effective modality for treatment of a renal calculus with benefits of simultaneous retrograde access and less operative time compared to the prone PCNL.

Keywords: Flank free percutaneous nephrolithotomy; Prone percutaneous nephrolithotomy; Supine percutaneous nephrolithotomy

1. Introduction

The successful removal of a kidney stone for the very first time through a nephrostomy tract was done in 1976, and percutaneous nephrolithotomy abbreviated as PCNL has been the go-to treatment modality for large and complex calculi replacing open surgical removal.[1]

PCNL is most commonly performed in the prone position,[2] as it provides access to the collecting system, thereby enabling puncture of a posterior calyx through the Brodel's avascular plane without significant renal hemorrhage and breach of the peritoneum. But in the prone position there is a decrease in the abdominal pressure and pulmonary capacity, thereby reducing the ability to tolerate an operation of long duration, leading to difficulty in patients who are obese or have underlying lung diseases.[3]

In 1987, Valdivia Uria presented supine PCNL and described the advantages of this simplified technique.[4] The supine position has a low impact on circulation and the pulmonary system. This makes it helpful to monitor and in turn may reduce the dose of anesthetics used in the patient and is quite useful in pediatric, geriatric, obese/overweight, and spinal deformity patients, and those who are debilitated.

The other benefits include the surgeon's hands being out of the fluoroscopic field of vision. The surgeon's benefits are an easier puncture of the kidney and the chance of endo-vision assisted kidney puncture and renal tract dilatation. A reduced chance of large bowel (colon) injuries and better maneuverability have been demonstrated.

The major drawback of this position is that the kidney is more easily pushed into a forward position by the puncture needle and by the fascial dilators, leading to a deeper channel.[5,6]

Considering the lack of studies on whether the traditional prone position versus the modified supine position is optimal for PCNL, this study was conducted to compare these 2 techniques in terms of operation duration, rate of success, stone clearance rate, safety, and their complications.

2. Materials and methods

An observational study of 100 patients were conducted in our institution after ethical committee clearance for 2 years from

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2018 to 2020 divided into 2 groups: 50 patients underwent modified supine PCNL and 50 patients underwent standard prone PCNL.

Patients in prone PCNL had general anesthesia. Patients randomly divided into the prone position group were placed in the lithotomic position, and retrograde ureteric catheterization was performed. All other procedures were completed in the prone position.

Patients in the modified supine group were placed in an intermediate supine-lateral position with a tilt of 15°, achieved by raising the flanks and stabilizing the position by bolsters. The ipsilateral leg was extended and the contralateral leg was abducted and flexed, achieving a modified lithotomic position. The ipsilateral arm was supported with a flexed elbow over the chest with the contralateral arm tucked next to the torso with an extended elbow as shown in Figure 1. The rest of the procedure followed the principles of PCNL, that is puncture, dilatation, and stone removal as shown in Figures 2 and 3.

In both positions the size of the channel was based on calyx size, which is our standard protocol for choosing which procedure is to be done (miniPCNL, Ultramini PCNL, or standard PCNL). The calyx was chosen based on surgeon preference which was mostly the single most favorable calyx, which would favor complete clearance. Occasionally a second puncture was required. Complete clearance was the goal in all cases. The energy source chosen was also according to surgeon choice with bigger stones being tackled with pneumatic lithoclast and cases with stones around 1.5 cm being tackled by holmium.

The measured data included operative time, number of punctures, stone-free rate, length of hospital stay, and rate of complications including pain, fever, and residual stone management. Pain was measured according to the Smiley pain scale or the Wong-Baker Faces Pain Rating Scale which is a pain scale that was developed by Donna Wong and Connie Baker. The scale shows a series of faces ranging from a happy face at 0, or "no hurt," to a crying face at 10, which represents "hurts like the worst pain imaginable." Based on the faces and written descriptions, the patient chooses the face that best describes their level of pain.[7] The data collected was subjected to analysis using SPSS software—chi-square and Fisher's exact tests. A p value <0.05 was considered statistically significant.

Figure 1. Flank free position in left and right renal calculus.

Figure 2. Fluoroscopic guided puncture with surgeon in a comfortable position. With no change in position of patient and no shifting of Endo-monitor Trolley required.

3. Results

We observed that there was not much difference in the mean age in the 2 groups. The supine PCNL group had a mean age of 40.16 years while the prone PCNL group had a mean age of 42.80 years. The number of male and females in each group were same. The mean size of the calculus in the supine PCNL group was 2.43 cm and that in the prone PCNL group was 2.60 cm.

The number of patients in the supine PCNL group that required more than 1 puncture was 6 and in the prone PCNL group it was 8. The location of the stones in both groups were similar with the majority of stones in the pelvis (the supine group had 86% and the prone group had 84%), 5 patients in each group had stones in the lower calyx and 2 patients in each group had stones in the upper calyx, and the prone group had 1 patient with a stone in the middle calyx.

Much difference was seen in the total time duration, the mean time for supine PCNL was 72.24 minutes (excluding anesthesia time) while for prone PCNL it was 88.12 minutes. The difference was in the time before puncture. The mean time before puncture to insert the ureteric catheter was 20.92 minutes in the supine

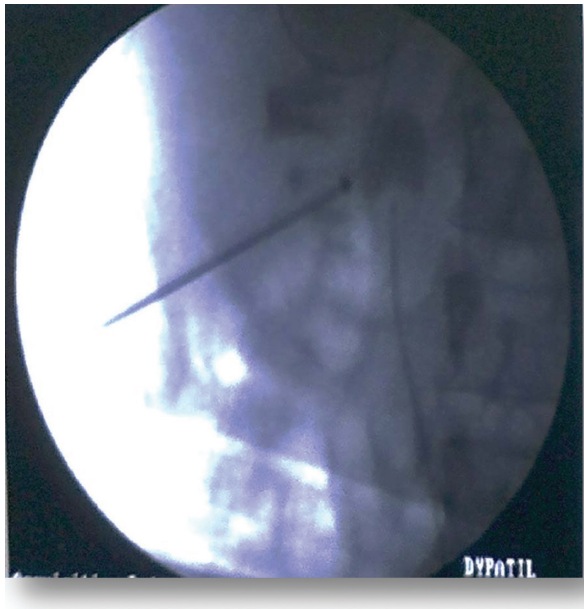

Figure 3. Successful puncture taken and single step dilation done over it on fluoroscopy.

PCNL group while in the prone PCNL group it was 31.84 minutes. The duration of stay was similar in both the groups as shown in Table 1.

The incidence of postoperative pain according to the Smiley grade was less than 5 in 44 patients in the supine PCNL group and only 6 patients had pain which was more than 5 in the Smiley score. In the prone PCNL group 34 patients had less than 5 on the Smiley score and 16 patients had pain of more than 5. Postoperative fever was seen in 4% of the supine group and 8% of the prone PCNL group.

Table 1

Observations and results.

Parameters (mean)	Supine PCNL	Prone PCNL
Age (yr)	40.16	42.80
Sex (n)		
Male	28	28
Female	22	22
Calculus size (cm)	2.43	2.60
Hb difference (g/dL)	0.37	0.61
TLC postoperative (10^3/dL)	9.87	10.75
Creatinine difference (ng/dL)	0.12	0.21
No. of punctures >1 puncture	6	8
Postoperative pain (Smiley Scale)		
<5	44	34
>5	6	
Postoperative fever (n)	2	4
Time from position (min)	72.24	88.12
Time from puncture (min)	51.32	56.28
Time before puncture (min)	20.92	31.84
Duration of hospital stay (d)	2.76	2.64
Type of energy		
Holmium	6	12
Lithoclast	34	38
Double J stent/nephrostomy/both		
Both	34	32
Nephrostomy	8	12
None	8	6

Hb = hemoglobin; PCNL = percutaneous nephrolithotomy; TLC = total leukocyte count.

4. Discussion

PCNL is one of the commonly adopted procedures for treatment of urolithiasis with a large size renal stone, that is stones larger than 20 mm^2, staghorn and partial staghorn calculi, and stones in patients with chronic kidney disease.[8] We evaluated 100 patients who underwent PCNL for urolithiasis and compared outcomes in patients undergoing the procedure in supine or prone positions.

The mean age of the patients in the supine PCNL group was 40.16 years (range 21–75 years) and in the prone PCNL group it was 42.80 years (range 23–65 years). The *p* value was not significant when the groups were compared. Multiple studies have shown gender predisposition of the male population in developing urolithiasis. Two large studies from France and Germany demonstrated a clear gender correlation of urolithiasis formation.[9,10] Studies have shown prevalence of urolithiasis is the highest in the age groups 40–49 and 30–39 years in males and females, respectively.[9] These findings of prevalence of urolithiasis in males can explain the male preponderance in our study. The mean age in the study correlates with the peak age of finding urolithiasis in the 4th to 5th decade of life.

The mean size of the calculus was similar when the groups were compared. The mean stone size in the supine PCNL group was 2.43 cm and in the prone PCNL group it was 2.60 cm. The *p* value was not significant at 0.49. The size or the location of the stone did not make much difference with respect to the position being used for doing PCNL.

The mean difference of hemoglobin in the supine PCNL group was 0.37 g/dL whereas in the prone PCNL group it was 0.61 g/dL. The *p* value was significant at 0.043 suggesting a higher blood loss when PCNL is performed in the prone position. In a recently conducted meta-analysis by Yuan et al.[11] It was found that blood loss was higher when PCNL was performed in the prone position when compared to the supine position. Also, it was noted that blood transfusions were significantly less when the procedure was conducted in the supine position.

The total leucocyte count performed subsequent to the PCNL procedure was not significant when the groups were compared. Similarly, the mean difference in change in creatinine levels was not significant when the groups were compared.

The number of punctures required to perform the procedure was similar in the groups with a not significant difference. There were 6 patients in the supine PCNL group who required more than one puncture whereas 8 patients in the prone PCNL group required more than one puncture. The *p* value was 0.68.

In some cases there might be incomplete removal of the stone, which reflects residual stones (4 mm or more) on imaging subsequent to the procedure. Of 100 patients, 4 patients in the supine PCNL group and 6 patients in the prone PCNL group had residual stones. The *p* value was not significant at 0.63. For all the patients in both groups no ancillary procedure was required. As the residual stone sizes were between 4 and 6 mm, patients were only kept on double J stents and followed-up. On follow-up at 4 weeks clearance was seen.

In a meta-analysis by Wu et al.,[12] it was noted that there was no significant difference in both the groups pertaining to the stone-free rate. A contrary meta-analysis by Yuan et al.[11]

showed higher stone clearance in the prone position due to ease of access. However, this difference was found to be not significant in our study.

Postoperative pain is an important indicator of patient's morbidity subsequent to surgery. Based on the Smiley scale 88% of patients had a score of ≤ 5 in the supine PCNL group, and 68% in the prone PCNL group. The rest of the patients had a higher intensity of pain of more than 5, 12% in the supine PCNL group and 32% in the prone PCNL group. However, the p value was not significant when the groups were compared.[13,14]

Postoperative fever was found in 2 patients in the supine PCNL group and 4 patients in the prone PCNL group. The p value on comparison was not significant at 0.52. In a study by Gutierrez et al.[15] approximately 10% of patients developed fever despite receiving antibiotics. They noted that the risk of postoperative fever increased in the presence of a positive urine bacterial culture, diabetes, staghorn calculi, and a preoperative nephrostomy.

The type of lithotripters included the holmium laser in 16 and 12 patients, respectively, in supine and prone PCNL whereas lithoclast (pneumatic lithotripser) was used in 34 and 38 patients, respectively, in supine and prone PCNL.

The use of a double J stent along with nephrosotomy was done in 34 patients in the supine PCNL group and in 32 in the prone PCNL group. Only nephrostomy was performed in 8 patients in supine PCNL and 12 in prone PCNL. Eight and 6 patients in supine and prone PCNL, respectively, did not require either a double J stent and nephrostomy. Pengfei et al. evaluated use of a double J stent in upper renal calculi and found similar stone clearance in groups with stent use or without it.[16]

The total duration of stay in hospital in patients undergoing supine PCNL was 2.76 days and those undergoing prone PCNL was 2.64 days. The p value was not significant at 0.44. There was no significant difference in hospital duration when the techniques were compared. Yuan et al.[11] noted a shorter operating time in patients operated in the supine position whereas the length of stay in hospital was found to be not significant when the groups were compared.

The mean time to finish from initial postion as shown in Table 1 was 72.24 minutes in supine PCNL and 88.12 minutes in prone PCNL. The p value was significant ($p < 0.001$) suggesting that the time from position is significantly earlier with supine PCNL. The mean time before puncture was 20.92 minutes in the supine position and 31.84 minutes in the prone position. The p value was significant ($p < 0.001$) suggesting that the time before puncture is significantly earlier with supine PCNL. The mean time from puncture as shown in Table 1 to finish was 51.32 minutes in the supine position and 56.28 minutes in the prone position. The p value was significant ($p < 0.001$) suggesting that the time from puncture is significantly earlier with supine PCNL.

Wu et al.[12] also noted a shorter mean operating time in patients operated on in the supine position, however this did not translate to a shorter stay in hospital. Various studies have shown a reduced operative time in patients undergoing PCNL in the supine position,[17–19] which is comparable to our study.

In an update by Patel et al.[20] they noted that the prone position and its modifications are the most widely used positions for PCNL, but with the introduction of various supine positions, the optimal position has been up for debate. Recent meta-analysis has shown a superior stone-free rate in the prone position and comparable complication rates to the supine position.

The advantage of ease of access to the urethra for simultaneous retrograde techniques in the supine position is also possible with modifications in the prone position such as the split-leg technique.[20]

Limitations of the study: 1) Long-term follow-up was not conducted on patients and outcome of the surgery. 2) The study sample is too low to extrapolate to regional and national level trends. 3) The study did not compare various supine positions such as slanting/oblique positions. 4) The study did not include pediatric patients.

5. Conclusions

As observed from this study, the supine position PCNL is associated with significantly reduced operating time when compared to conventional prone position PCNL procedures. The postoperative complications such as pain and fever were not significant when compared in both groups. The blood loss was also significantly less in the supine position when compared as difference of hemoglobin. Hence, the supine PCNL is an equally effective modality for treatment of a renal calculus with benefits of simultaneous retrograde access and less operative time compared to prone PCNL. We suggest further studies by recruiting more patients and evaluating the supine position compared to the prone position in performing the PCNL procedure.

Acknowledgments

None.

Statement of ethics

This study was approved by Institutional Ethics Sub-committtee on 31/01/2018. There's a waiver of the participants' consent according to local registrations. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of interest statement

The authors report no conflict of interests.

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Author contributions

All authors contributed equally in this study.

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