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Comparison of Supine and Prone Positions' Outcomes in Percutaneous Nephrolithotomy

Perkütan Nefrolitotomide Supin ve Pron Pozisyonlarının Sonuçlarının Karşılaştırılması

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ÖZET

Amaç: Çalışmada supin ve pron olarak iki farklı perkütan nefrolitotomi pozisyonunun ameliyat öncesi demografik veriler, perioperatif bulgular ve cerrahi sonuçlar açısından karşılaştırılması amaçlandı.

Gereç ve Yöntemler: Ocak 2019 ile Aralık 2023 arasında perkütan nefrolitotomi yapılan 18 yaş ve üzeri 2-4 cm arası renal taşları olan hastalar çalışmaya dahil edildi. Operasyon notlarından elde edilen veriler ile hastalar supin ve pron grup olmak üzere ikiye ayrıldı. Yaş, cinsiyet, vücut kitle indeksi (VKİ), kronik hastalıklar gibi demografik veriler her iki grup arasında karşılaştırıldı. Operasyon süresi, perioperatif komplikasyonlar ve postoperatif takip verileri toplanarak her iki grup arasında karşılaştırıldı.

Bulgular: Çalışmaya 56'sı (%53) supin grupta, 49'u (%47) pron grupta olmak üzere 105 hasta alındı. Yaş, cinsiyet, VKİ, taş lokalizasyonu, taş boyutu, Hounsfield ünitesi gibi demografik ve preoperatif veriler benzerdi. Perioperatif bulgular karşılaştırıldığında, cerrahi süre supin grupta daha kısaydı (101 (95-107) dk vs. 135 (126-145) dk, p<0.001). Hemoglobin seviyesindeki ortalama düşüş her iki grupta benzerdi (p>0.05). Gözlenen baskın postoperatif komplikasyon, 14 hastada (%13,3) ortaya çıkan ateşti. Taşsızlık oranı supin grupta %83,9, pron grupta ise %83,6 idi (p>0.05).

Sonuç: Perkütan nefrolitotomi de pozisyon seçimi cerrahın tecrübesine göre farklılıklar gösterebilmektedir. Supin ve pron pozisyonlar sonuçlar açısından benzer olmakla birlikte supin pozisyon daha kısa operasyon süresi ile ilişkilidir.

Anahtar Kelimeler: perkütan nefrolitotomi, nefrolitiyazis, supin, pron

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ABSTRACT

Objective: The study aimed to compare two different percutaneous nephrolithotomy positions with the evaluation of preoperative demographic data, perioperative findings and surgical outcomes.

Material and Methods: Patients aged 18 years and older with renal stones measuring 2-4 cm who underwent percutaneous nephrolithotomy between January 2019-December 2023 were included in the study. Patients were divided into two groups as supine and prone based on the data obtained from the operation notes. Demographic data such as age, gender, body mass index (BMI), and chronic diseases were compared. Operation time, perioperative complications, and postoperative follow-up data were collected and compared between the two groups.

Results: A total of 105 patients were included in the study, 56 (53%) in the supine group and 49 (47%) in the prone group. Demographic and preoperative data such as age, gender, BMI, stone localization, stone size, and Hounsfield unit were similar. When comparing perioperative findings, surgical time was shorter in the supine group (101 (95-107) min vs. 135 (126-145) min, $p<0.001$). The mean decrease in hemoglobin was similar in both groups ($p>0.05$). The most common complication was fever, manifesting in 14 patients (13.3%). The stone-free rate was 83.9% for supine group and 83.6% for prone group ($p>0.05$).

Conclusion: The choice of position in percutaneous nephrolithotomy may vary depending on the surgeon's experience. Although supine and prone positions are similar in terms of results, the supine position is associated with shorter operative time.

Keywords: Percutaneous nephrolithotomy, Nephrolithiasis, Supine, Prone

INTRODUCTION

Percutaneous nephrolithotomy (PNL) is an endourological surgical approach used for kidney stones larger than 2 cm. The decision regarding whether to opt for the supine or prone positions during surgery may hinge on the surgeon's expertise and the suitability of the surgical table and X-ray machinery (1). In literature studies which prone and supine positions are compiled, there are studies reporting similar stone-free rates between the two methods (2).

PNL was initially outlined by Fernstrom and Johansson, who conducted the procedure on three patients while they were in the prone position (3). The supine PNL, however, has gained prominence due to its better anesthesia tolerability and maintenance of normal respiratory functions, making it a suitable method for elderly patients with comorbidities (4). While literature suggests that supine PNL is associated with shorter operation times and lower complication rates, prone PNL is advantageous for multiple and upper caliceal access (5). In another meta-analysis, stone-free status was reported to be higher in prone PNL position and as a complication fever was reported to be less common in the supine position during postoperative follow-up (6). Despite these reported outcomes, the choice of position remains a topic of debate among clinicians. Due to these controversial results in the literature and the lack of clear recommendations on which method should be preferred for which patients, we aimed to contribute to the literature with the results of both methods that we have experienced clinically.

Based on the variability in the results of these reported studies, we aimed to compare the preoperative data, stone characteristics, perioperative and postoperative complications, and stone-free rates between two surgical positions.

MATERIALS AND METHODS

After obtaining local ethical approval, the study was initiated (Approval No: BAEK 2024/01-23). The retrospective collection of medical records involved PNL applied patients between January 2019 and December 2023. Inclusion criteria were those aged 18 and over with stones measuring 2-4 cm located only in the renal pelvis or in one of the lower or middle calyces. Patients with horseshoe kidney, chronic renal failure, a history of PNL or open nephrolithotomy, or staghorn stones were excluded.

Supine and prone groups were created by obtaining from the operation notes. Patients' age, gender, body mass index (BMI), and prevalent comorbidities such as diabetes mellitus (DM), hypertension (HT), and chronic heart, lung diseases

were extracted from patient hospital files and meticulously compared between the two groups. Stone characteristics, including stone diameter, volume, laterality, Hounsfield unit (HU), and preoperative presence of urinary infection were obtained from non-contrast-enhanced computed tomography (NCCT) of the abdomen performed preoperatively. Intraoperative findings, including bleeding, surgical and fluoroscopy time; perioperative findings; and postoperative complications (classified according to modified Clavien-Dindo(7)), such as fever, bleeding, and urosepsis, were recorded from the operation notes. Postoperative NCCT was performed in the first month to evaluate residual stone status. Stone-free was accepted as residual fragments below 4 mm.

PNL Technique

General anesthesia was administered for all patients during PNL. The supine position is achieved using the Galdakao-modified supine Valdivia (GMSV) position as described by Iberlzea and colleagues (8). After positioning, a retrograde pyelography is performed to identify the appropriate calyx for puncture via ureteral catheter. Once the calyx is punctured, a guidewire is placed to calyx or renal pelvis. The tract is then dilated up to 24F using Amplatz dilators, and access is secured. Pneumatic system was used to fragment the stones. Fragments were removed with stone forceps and irrigation water. DJ stent was placed nephrovesically. The nephrostomy tube was placed into the renal pelvis through the percutaneous tract. Differently, for the prone position, the patient was initially given a lithotomy position and an ureteral catheter was placed. Then, the prone position applied for the patient and same steps were performed.

Statistical Analysis

SPSS Statistics version 22 was used for statistical analysis. Descriptive statistical data were presented for the parameters included in the study. The chi-square test was used to compare categorical variables. If chi-square test multi-cell table results were more than 20% (i.e. 1 in 5) of have less than 5 cases, Fischer's exact test used. Kolmogorov-Smirnov test was used for the normality of continuous variables. For non-normally distributed variables, the Mann-Whitney U test was used. $p<0.05$ was accepted statistically significant.

RESULTS

Of the 105 patients who underwent PNL included in the study, 56 (53%) were performed in the supine position, while 49 (47%) were performed in the prone position. The median age of patients for supine group was 45 (38-56) years, for prone group was 44 (38-48) years. There were 65 male patients (61%) and 40 female patients (39%). The median stone diameter for supine group was 29 (27-32.5) mm, for prone group was 24 (22-26) mm. Urinary infection detected 11 (18.6%) patients in supine group, and 9 (18.3%) in prone group ($p>0.05$). Preoperative demographic and clinical characteristics like age, gender, BMI, American Society of Anesthesiologists (ASA) scores, and stone characteristics were similar (Table 1).

When comparing perioperative findings, surgical time was shorter in the supine group (101 (95-107) min vs.135 (126-145) min, $p<0.001$). The median fluoroscopy time was 32 (23-41) seconds in the supine group and 35 (24-40) seconds in the prone group ($p=0.142$). Intraoperative bleeding was observed in 7 patients (%6.6) and there was no difference between the groups. Another complication, visceral injury was a colon injury (Clavien-dindo grade 3b) detected in one patient who was in prone group. The prevailing postoperative complication observed was fever (Clavien-dindo grade 1), manifesting in 14 patients (13.3%). Systemic inflammatory response syndrome (SIRS) (Clavien-dindo grade 2) was seen in 4 patients (3.8%), with 3 of them (2.8%) developed sepsis (Clavien-dindo grade 4a). The median decrease in hemoglobin was similar in both groups (1 (0.8-1.4) vs. 1.1 (0.7-1.7) g/dl, $p=0.867$). Blood transfusion (Clavien-dindo grade 2) was seen 3 (5.3%) patients in supine group, 2 (4%) patients in prone group. The stone-free rate was 83.9% for supine group and 83.6% for prone group ($p=0.914$). The perioperative findings and outcomes are shown in Table 2.

Table 1. Comparison of demographic and clinic variables between supine PNL group and prone PNL group

Variables	Supine	Prone	P value
Number of patients, n (%)	56 (53%)	49 (47%)	
Median age, (IQR) (yrs)	45 (38-56)	44 (38-48)	0.857*
Gender, n (%)			
Male	36 (64.3)	29 (59.2)	0.591#
Female	20 (35.7)	20 (41.8)	
Median BMI, (IQR) (kg/m2)	25 (23-27)	24 (22-26)	0.094*
ASA, n (%)			
ASA 1	46 (82.1)	41 (83.7)	0.921#
ASA 2	5 (8.9)	5 (10.2)	
ASA 3	4 (7.1)	3 (6.1)	
ASA 4	1 (1.8)	0 (0)	
Median stone diameter (IQR), (mm)	29 (27-32.5)	29 (28-32)	0.617*
Median stone volume (IQR), (mm3)	4062 (3150-4960)	3902 (3512- 5242)	0.521*
Median stone density (IQR), HU	1120 (972-1278)	1140 (990-1190)	0.921*
Laterality, n (%)			0.814#
Right	31 (55.4)	26 (53.1)	
Left	25 (44.6)	23 (46.9)	
Presence of urinary infection	11 (18.6)	9 (18.3)	0.868#

* Mann whitney U test

Pearson chisquare test

SD, standart deviation; BMI, body mass index; ASA, American society of anaesthesiology; HU, hounsfield unite; IQR, interquartile range

Table 2. Comparison of perioperative findings and outcomes between supine PNL group and prone PNL group

Variables	Supine	Prone	P value
Median operation time, (IQR), (min.)	101 (95-107)	135 (126-145)	<0.001*
Intraoperative complications, n (%)			
Bleeding	4 (7.1)	3 (6.1)	1.000&
Visceral injury (Clavien-dindo grade 3b)	0 (0)	1 (2.0)	0.467&
Median floroscopy time, (IQR), (s.)	32 (23-41)	35 (24-40)	0.142*
Postoperative complications, n (%)	8 (14.3)	6 (12.2)	0.759#
Fever (Clavien-dindo grade 1)	3 (5.3)	2 (4.0)	1.000&
Blood transfussion (Clavien-dindo grade 2)			
SIRS (Clavien-dindo grade 2)	2 (3.5)	2 (4.0)	1.000&
Sepsis (Clavien-dindo grade 4a)	1 (1.7)	2 (4.0)	0.597&
Median hemoglobine loss, IQR, g/dl	1 (0.8-1.4)	1.1 (0.7-1.7)	0.867*
Hospitalization time ± SD, days	3.9 ± 0.8	3.7 ± 0.8	0.594*
Median hospitalization time, IQR, days	4 (3-4)	4 (3-4)	0.594*
Control NCCT findings, n (%)			0.914#
Stone free	47 (83.9)	41 (83.6)	
Residual stone	9 (16.1)	8 (16.4)	

* Mann whitney U test

& Fischer-exact test

Pearson chisquare test

SD, standart deviation; min., minutes; g/dl, gram/deciliter; NCCT, Non-contrast computerized tomography; IQR, interquartile range

DISCUSSION

Percutaneous nephrolithotomy, which was first described in the prone position, is now frequently performed in the supine and prone positions, although this may vary with the experience of the surgeon. While supine position stands out for its shorter operation time and anesthesia tolerability, the prone position offers better access to multiple calices (9). According to Küçükyangöz et al., the percentages of the supine and prone groups that were stone-free were 83.1% and 81.1%, respectively (10). In a different study, Tokatlı et al. found that the supine and prone groups had stone-free rates of 85.1% and 87.3%, respectively (11). Comparing both positions during PNL, a systematic study found that the frequencies of stone-free outcomes were comparable (2). Stone-free rates were 83.9% for supine and 83.6% for prone groups in our sample. However, despite the similar stone-free rates observed in literature and our study, the potential advantage of the supine position in accessing residual stones through endoscopic retrograde procedures may be an alternative advantage. Victor A. Abdullatif et al. reported that endoscopy combined with retrograde intrarenal surgery demonstrated higher stone-free rates compared to percutaneous nephrolithotomy alone (12).

A meta-analysis conducted by Keller et al. stated that surgical time was statistically significantly lower in the supine group (13). With the decrease in surgical time, the absence of pressure on the thorax in the prone position makes the supine position more preferable in terms of respiratory and cardiovascular functions. In a comparative study by Tokatlı et al., no cardiovascular or respiratory complications were observed in either group following percutaneous nephrolithotomy; however, it was reported that patients in the supine group had higher ASA scores (11). In our sample, we didn't observe any cardiovascular and respiratory complications. This finding can be a comment about that both positions are reliable in this regard.

Percutaneous nephrolithotomy, as one of the minimal invasive endourological surgical methods, is not devoid of complications (14). Among the most common complications are infective complications, bleeding, and organ injuries, which can lead to clinical conditions with mortality risk. While bleeding requiring transfusion is reported in literature studies ranging from 1% to 34%, arteriovenous fistula in the postoperative period is reported around 1% (15). In our study, 4% of patients required transfusion for bleeding, and no patient developed arteriovenous fistula. The comparison of bleeding-related complication rates were similar in our sample. Our findings are consistent with literature and support the safe application of both methods regarding bleeding.

Infective complications after percutaneous nephrolithotomy are reported between 2.4% and 40.4% (16). Factors such as operation time, preoperative urinary infection, stone size, and positive stone culture are associated with infective complications after percutaneous nephrolithotomy (17). In our study, the predominant infective complication encountered in both groups was fever, and similar rates were observed between the groups. The high fever rates may be attributed to the high rates of urinary infection in the patients in our sample. Considering the literature data and our findings, we believe that the position in percutaneous nephrolithotomy is not a risk factor for infective complications.

During percutaneous nephrolithotomy, organ injury, a major complication, is most commonly observed in the colon, pleura, liver, small intestine, duodenum, spleen, and gallbladder (18). Surgeon's experience and preoperative imaging contribute to reducing organ injury; however, it remains a significant clinical concern. While some studies in the literature associate colon injury with the supine position, similar results have been reported in other series (19). Colon perforation was observed one patient in our sample. Although this complication was observed in the prone position, the sample size and statistical results are not sufficient to establish a clear association.

Our study has some limitations oriented from retrospective design. The inability to access intraoperative hemodynamic parameters prevented us from comparing the groups based on these variables. Additionally, the sample predominantly consisted of ASA 1 and 2 patients, limiting the evaluation of the safety of the positions in patients with comorbidities. Another limitation is that the time to reach the stone, which is one of the parameters we could not reach due to the retrospective design, and which could be taken into account in the evaluation of both surgical methods, could not be obtained. However, our study contributes to the literature by showing that both positions are effective and reliable and that the supine position related with shorter surgery time.

CONCLUSIONS

In conclusion, both prone and supine positions can be effectively and safely utilized in percutaneous nephrolithotomy with similar success rates and complication profiles. The supine position stands out because it shortens the surgical time for the patient and the surgeon. Larger sample size studies are needed to evaluate both positions' outcomes.

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Conflict of Interest: The authors declare that they have no conflict of interest.

Ethics Committee Approval: This study was approved by the Ataturk University Local Ethics Committee (approval number: BAEK 2024/01-23).

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