Supine *versus* Prone Miniaturised Percutaneous Nephrolithotomy in Elderly Patients

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ABSTRACT

Objective: To compare the outcomes of mini-PCNL (miniaturised percutaneous nephrolithotomy) in prone and supine positions in elderly patients.

Study Design: Cohort study.

Place and Duration of Study: Department of Urology, University of Health Sciences, Turkey, between April 2017 and January 2021.

Methodology: Patients over 65 years of age were included in the study. All patients' comorbidities were recorded and charlson comorbidity index (CCI) score was calculated. The groups were compared in terms of perioperative values, stone-free rates and complication rates. Logistic regression analysis was used to evaluate risk factors for complication development. Postoperative complications were noted according to the Clavien scoring system (CSS).

Results: There were 54 patients in the supine mini-PCNL group and 64 in the prone mini-PCNL group. The median ages were 67 in the prone and 66 in the supine group. CCI scores were similar in both groups ($p = 0.735$). Stone-free and total complication rates were not statistically different in the groups ($p = 0.994$ and $p = 0.247$, respectively). However, grade 1-2 complication rates were significantly higher in the prone group ($p=0.020$). CCI score and stone size were significantly associated with the development of complications ($p = 0.018$ and $p = 0.034$, respectively).

Conclusion: The present study is the first to compare the outcomes of mini-PCNL in prone and supine position in geriatric patients. Supine mini-PCNL is a potentially safer alternative treatment method for older patients with high CCI scores.

Key Words: *Percutaneous nephrolithotomy, Supine position, Elderly, Mini-PCNl, CCI score.*

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INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is the accepted standard treatment for moderate – large renal calculi, according to EAU guidelines.[1] The reported success rates of PCNL in various studies are between 51% and 100%, and reported complication rates reached 83%.[2] However, despite high stone-free rates for PCNL, some authors reported higher rates of complications caused by oversized instrument and tract size.[3] Mini-PCNL was developed as a solution, resulting in lower complication rates through 14-22 French (Fr)-tract size.[4]

Usually, prone position is used for PCNL, which allows manouverability for direct and convenient access to the collecting system. Prone position significantly reduces the risk of bleeding, because it allows clear access Brodel's avascular renal parenchyma. However, it may cause problems associated with circulatory and ventilatory, because of compression on the chest. Cervical spine injuries, tracheal compression, and ocular injury may occur during manipulation of the patient's position. The supine position has advantages, including less pressure in the renal pelvis due to the downward direction of the tract, both reducing the risk of liquid absorption, and allowing easier spontaneous cleaning of parts of the stone with gravitational drainage of fluid. In addition, this position facilitates simultaneous performance of PCNL and ureteroscopic (URS) procedures, as well as improved airway control in the patient. It also enables the surgeon to be seated during the operation. PCNL performed in the supine position provides a more appropriate operation process, especially for patients with pulmonary or cardiovascular disease.[5]

There is currently no worldwide consensus over which technique is preferable; therefore, urologists' decisions must take into account the needs of geriatric patients, who have a tendency to bleed, and have low cardiopulmonary performance. Although many studies have researched the results of prone PCNL in geriatric cases; however, no study has evaluated the role of supine position on PCNL outcomes in elderly patients.

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The objective of this study was to investigate the outcomes of mini-PCNL comparing prone and supine positions in geriatric patients.

METHODOLOGY

The data of patients over 65 years of age, who underwent mini-PCNL at Department of Urology, University of Health Sciences, Turkey, between 2017 and 2021, were retrospectively analysed. The study was approved by Ethical Board (Meeting Decision No. 2021/174). The researchers excluded patients with neuromuscular disease, renal anomalies, coagulopathy, skeletal deformity and having a solitary kidney. Demographic characteristics, perioperative and postoperative results of the patients were compared between the groups.

Stone size was recorded as the longest diameter of the stone (longitudinal or transverse). In multiple intrarenal stones, individual stone sizes were recorded and then the total size calculated. Perioperative data included operative and fluoroscopy time, time of hospitalisation, access localisation, and success and complication rates. Moreover, postoperative complications were classified according to the Clavien scoring system. Logistic regression analysis was used in the assessment of risk factors for the development of complications. Charlson comorbidity index (CCI) score was measured for all patients.

A total of 118 patients were divided into two groups, according to surgical technique. After the urine culture was confirmed to be negative, they were taken to the operation room. All procedures were performed under general anesthesia. After placement of 5 F ureteral catheter with fluoroscopy aid in Galdakao--modified supine Valdivia position, for each patient, a single renal access to the appropriate calyx was obtained with 18-gauge needle under ultrasound-assisted fluoroscopic guidance below the 12th rib. At the end of the procedure, supine mini-PCNL was completed by checking the ureter under direct vision by semirigid URS for residual stone. After urethral catheter insertion, pads were placed under the patient to achieve prone position, in order to allow the appropriate puncture, under the guidance of fluoroscopy. Mini-PCNL was performed through a 16.5 Fr amplatz sheath. Stone fragmentation was accomplished using a 12 Fr nephroscope (Karl Storz, Tuttlingen, Germany) with Holmium Yag Laser (Sphinx, Lisa laser, USA). The surgeon decided whether to insert a JJ catheter and/or nephrostomy tube; no totally tubeless procedures were performed.

The operative time was calculated from the initial puncture for an access tract to the final placement of nephrostomy tube or JJ catheter. All PCNL interventions were performed by two same experienced surgeons. A non-contrast CT was performed in first postoperative month, and success was defined as a total stone clearance.

The statistical package for the social sciences version 25 (SPSS IBM Corp., Armonk, NY, USA) programme was used. Normality of distribution of the variables was checked by Shapiro-Wilk test. Mann-Whitney U-test was used for comparison of the variables between the groups. Descriptive data were given as median (quartile 1-quartile 3) for continuous variables. Categorical variables were grouped and compared using the $\chi 2$ test or Fisher's exact test. Logistic regression analysis was performed to evaluate the parameters that were predicted to be risk factors for the development of complications. The data were analysed at a 95% confidence level, and a p value of less than 0.05 was accepted as statistically significant.

RESULTS

Fifty-four patients were treated with supine mini-PCNL, and 64 with prone mini-PCNL. The median ages were 67 (66-68) in prone group and 66 (65-67) in supine group. The two groups' preoperative characteristics (age, ASA score, body mass index (BMI), CCI score and gender) were similar ($p > 0.05$). The two groups also had similar rates of stone opacity, localisations and size, hounsfield unit of stone values ($p = 0.421$, $p = 0.878$, $p = 0.266$ and $p = 0.636$, respectively, Table I).

Mean operation times of the two groups were similar ($p = 0.063$). The median fluoroscopy time for supine mini-PCNL and prone mini-PCNL groups was 1.0 (1.0-2.0) minutes and 2.0 (2.0-3.0) minutes, respectively ($p < 0.001$). However, the prone mini-PCNL group recorded longer hospital stay ($p < 0.001$). The success rate was 79.6% for the supine mini-PCNL group and 79.7% for the prone mini-PCNL group, and the results were statistically similar ($p = 0.994$).

Despite similar total complication rates between groups (20.4% and 29.7%, respectively, $p = 0.247$), minor complication rates were significantly higher in the prone mini-PCNL group (20.3%) than in the supine mini-PCNL group (5.5%) ($p=0.020$, Table II).

Clavien Grade 1 complications were observed in two patients in supine mini-PCNL group and eight patients in prone mini-PCNL group. One patient in supine mini-PCNL group and four patients in prone mini-PCNL group required transfusion (Clavien Grade 2), and in prone mini-PCNL group, fever requiring antibiotic replacement was detected in one patient in the postoperative period (Clavien Grade 2). Five patients in supine mini-PCNL group and three in prone mini-PCNL group required JJ stent insertion under anesthesia (Clavien Grade 3, Table II).

Binary logistic analysis was used to assess operation method, stone size, operation time and CCI score, which are predicted as risk factors for the development of complications. Stone size greater than 25 mm and CCI score ≥ 2 were found statistically significant in terms of complication development ($p = 0.034$ and $p=0.018$, respectively). Odds ratio was calculated as 2.616 (95% CI: 1.1-6.4, $p = 0.034$) for stone size and 2.954 (95% CI: 1.2-7.3, $p = 0.018$) for CCI score (Table III).

DISCUSSION

It is important to choose the most suitable method when treating kidney stones in elderly patients, due to multiple comorbidities. Minimally invasive treatment or observation may be an option when presence of serious comorbidities. However, high percentage of geriatric patients have rapid stone growth.[6]

Table I: Comparison of patient demographic data, preoperative findings and stone properties by groups.

	Supine group (n:54)	Prone group (n:64)	p-*value*
Age, years, median*	66 (65-67)	67 (66-68)	0.062[a]
Gender (male/female) Male Female	 27 (50.0%) 27 (50.0%)	 42 (65.6%) 22 (34.4%)	0.086[b]
BMI (kg/m²)*	31.1 (28.3-32.3)	30.0 (27.6-32.0)	0.083[a]
ASA score*	2 (1-2)	2 (2-2)	0.217[a]
CCI score 0-1 ≥2	 27 (50.0%) 27 (50.0%)	 34 (53.1%) 30 (46.8%)	0.735[b]
Previous stone surgery	14 (25.9%)	23 (35.9%)	0.243[b]
Stone opacity	49 (90.7%)	55 (85.9%)	0.421[b]
Stone localization Pelvis Lower pole Upper pole Multiple calyx Partial staghorn	 32 (59.2%) 7 (12.9%) 5 (9.2%) 6 (11.1%) 4 (7.4%)	 40 (62.5%) 9 (14.0%) 7 (10.9%) 6 (9.4%) 2 (3.1%)	0.878[c]
Stone size (mm)*	20.5 (19.3-30.0)	20.5 (16.3-25.0)	0.266[a]
Hounsfield unit*	881.5 (651.8-1202.3)	888.0 (723.8-1048.8)	0.636[a]
Presence of hydronephrosis	35 (64.8%)	38 (59.4%)	0.544[b]

**Median (quartile 1- quartile 3), [a] Mann-Whitney U-test, [b] χ2 test, [c] Fisher's Exact test. Asa: American society of anesthesiologists, BMI: Body mass index, CCI: Charlson comorbidity index.*

Table II: Comparison of operation data, postoperative follow-up results and complications between groups according to Clavien Dindo classification.

	Supine group (n:54)	Prone group (n:64)	*P-value*
Duration of operation (min)*	80.0 (70.0-90.0)	90.0 (76.0-90.0)	0.063[a]
Duration of fluoroscopy (min)*	1.0 (1.0-2.0)	2.0 (2.0-3.0)	*<0.001*[a]
Side of operation Right Left	 19 (35.2%) 35 (64.8%)	 26 (40.6%) 38 (59.4%)	0.544[b]
Access localization Lower calyx Middle calyx Upper calyx	 35 (64.8%) 16 (29.6%) 3 (5.5%)	 44 (68.7%) 14 (21.8%) 6 (9.4%)	0.570[c]
Number of Access 1 2 3	 54 (100.0%) 0 (0%) 0 (0%)	 58 (90.6%) 5 (7.8%) 1 (1.6%)	0.062[c]
Intercostal access	0 (0%)	3 (4.6%)	0.249[c]
Nephrostomy catheter placement	38 (70.4%)	44 (68.7%)	0.849[b]
Jj stent placement	27 (50.0%)	33 (51.5%)	0.866[b]
Hospitalization time (hours)*	48 (24-72)	72 (48-96)	*<0.001*[a]
Success	43 (79.6%)	51 (79.7%)	0.994[b]
Hematocrit drop (%)*	2.0 (0.9-5.8)	2.3 (0.2-4.8)	*0.370*[a]
Complications Clavien dindo classification 1-2 Clavien dindo classification 3-5	11 (20.4%) 3 (5.5%) 8 (14.8%)	19 (29.7%) 13 (20.3%) 6 (9.4%)	0.247[b] *0.020*[b] 0.363[b]
Clavien 1 Fever Pleural effusion (watchful waiting) Urinary leakage (watchful waiting)	2 (3.7%) 1 (1.8%) 1 (1.8%) -	8 (12.5%) 3 (4.7%) 3 (4.7%) 2 (3.1%)	0.107[c]
Clavien 2 Transfusion Fever requiring antibiotic replacement	1 (1.8%) 1 (1.8%) -	5 (7.8%) 4 (6.2%) 1 (1.6%)	0.217[c]
Clavien 3 Requirement for jj stent placing Angioembolization Thoracic tube placing	6 (11.1%) 5 (9.2%) 1 (1.8%) -	5 (7.8%) 3 (4.7%) 1 (1.6%) 1 (1.6%)	0.539[b]
Clavien 4a Acute renal failure (ICU) Urosepsis	2 (3.7%) 1 (1.8%) 1 (1.8%)	1 (1.6%) 1 (1.6%) -	0.592[c]

**Median (quartile 1- quartile 3), [a] Mann-Whitney U-test, [b] χ2 test, [c] Fisher's Exact test.*

Table III: Logistic regression analysis of risk factors for development of complications.

	Odds ratio	%95 CI	p-*value*
Groups (prone vs supine)	0.538	0.2-1.3	0.176
Stone size (≤25mm vs >25mm)	2.616	1.1-6.4	*0.034*
Duration of operation (≤90min vs >90min)	1.226	0.4-3.6	0.708
CCI score(0-1 vs ≥2)	2.954	1.2-7.3	*0.018*
CCI: Charlson comorbidity index, CI: Confidence interval.			

Another issue is that renal stones might cause urinary tract infection, obstruction, and pain requiring analgesic intake, which deteriorates renal function in elderly patients. The miniaturisation of instruments, enabled by developments in technology (endoscopy and optic quality), means that mini-PCNL under prone position can be reliably and effectively applied in the treatment of renal stones, in elderly patients according to recent reports.[7,8] Supine position in PCNL provides benefits such as decreased operative time, radiation exposure, risk of circulatory and respiratory compromise, and anesthesiological advantages in the intraoperative management of such patients; despite these gains, no study has yet compared supine and prone mini-PCNL in elderly patients.

Although previous studies emphasised that PCNL causes a similar hemoglobin drop in elderly and younger patients, changes in the cardiorespiratory reserve make elderly patients more vulnerable to bleeding. Sahin *et al*. reported similar transfusion rates for younger and older patients, following PCNL (18% and 21%, respectively).[9] Correspondingly, Iqbal *et al.* found no statistical difference in hemoglobin change between elderly and younger patients.[10] In contrast, Resorlu *et al*. found that hemorrhage was a predictive factor for medical complication in elderly patients.[11] In Ozgor *et al.,* elderly patients underwent mini-PCNL, and the mean hemoglobin drop was found to be 1.1 g/dl.[7] In accordance with the literature, in the present study, mean hematocrit drop was detected 3.3% and 2.7% in supine and prone mini-PCNL group, respectively, no statistically significant difference. Transfusion rate was slightly higher in prone mini-PCNL group, which can be explained by greater occurrence of multiple punctures.

A longer operative time increases anesthesia exposure, and thus possible risks for elderly patients. An analysis by Hersey *et al*. showed that, in geriatric patients, prolongation in operative time was independently related to increased likelihood of postoperative thromboembolism, transfusion, urinary tract infection, and total complications.[12] Previous studies have reported that age itself was not a negative factor affecting operation duration in PCNL, for example, Iqbal *et al*. found no statistically significant difference in older and younger patients' mean operative times following PCNL.[10] Falahatkar *et al*. reported significantly shorter operative time for the supine approach.[13] In contrast the recent review of 11 studies on comparison of supine and prone PCNL by Birowo *et al* revealed that all reported a mean operation time, and none found a significant difference.[14] Similarly, the present study reported no significant time difference between both groups, perhaps because the operation time did not include the period before the initial puncture. Using ultrasound guidance during the puncture, it has been found to decrease the period of radiation exposure.[15] This was confirmed in the current study, in which fluoroscopy time was found to be significantly lower for supine mini-PCNL, due to ultrasound guidance for renal puncture.

In the literature, there is no consensus about the effect of age or patient positioning during surgery on hospitalisation stay. Okeke *et al.* stated that hospitalisation time after PCNL was longer in older patients.[16] In contrast, Iqbal *et al*. and Sahin *et al*. reported no significant difference regarding age in terms of hospitalisation time in PCNL patients.[9,10] Some studies suggest that patient positioning during surgery may lead to cerebral desaturation, and that elderly patients in the prone position are more vulnerable.[17] Cerebral desaturation has been associated with postoperative cognitive dysfunction and longer PACU and hospitalisation stay in studies on general surgery patients.[18] In contrast, Tokatli *et al*. concluded that surgical position had no effect on hospitalisation stay after mini-PCNL.[19] In this study, there was significantly longer hospitalisation time for prone mini-PCNL in elderly patients, perhaps due to this particular position during surgery, and significantly higher minor complication rates, all of which require management.

The effect of patient positioning in PCNL on success is controversial. Some meta-analysis in the literature finds evidence for higher success in favour of prone PCNL,[20] while others find no evidence of significant difference.[13,21] In previous studies, it was thought that the higher stone-free rate in prone PCNL was due to the greater mobility of the nephroscope, and the difficulty in achieving upper pole access in the supine PCNL.[20] This was resolved by modifying the supine position, such as in a Galdakao modified Valdivia position, providing more space for nephroscope manipulation and a larger area for puncture, and moreover, allowed the simultaneous performance of the URS during operation, which increased the success rate. Horizontal or slightly inclined downward tract improved descending drainage and facilitated retrieval of stone fragments, and low intrapyelocaliceal pressure prevented fragment dislocation to other calices.[21] Aging, another possible factor in success, has not in fact been shown to have any effect in studies. Anagnostou *et al.* showed no statistical difference in stone-free rates following PCNL between younger patients and elderly patients (age > 70 years).[22] In a study by Hu *et al.* on 104 elderly patients, who underwent prone mini-PCNL, the stone-free rate in the first month was found to be 83.8%. In their study, SFR were

determined at one month postoperatively with kidney-ureter-bladder radiography, ultrasonography or CT.[8] In the current study, in contrast, for greater accuracy, the authors used abdominal CT to determine stone-free status at one month postoperatively. Acceptable stone-free rates were found in elderly patients, and results for supine and prone mini-PCNL were similar, 79.6% and 79.7%, respectively.

Despite the proof of the effectiveness of the PCNL procedure, complication rates of up to 83% were reported in the literature.[15] Li *et al.*'s recent meta-analysis of 15 studies consisting of a total of 1,474 patients, reported overall complications rates of 16.1% in the supine group and 19.2% in the prone group, *i.e.*, no significant difference was observed.[21] In the present study on elderly patients, the overall complications rate was 20.4% in supine mini-PCNL and 29.7% in prone mini-PCNL. Although this difference in overall complication rate was not statistically significant, the minor complication rate was found significantly higher in the prone group. The higher incidence of urinary leakage and fever in the prone position might be associated with the inability to intervene in ureteral obstruction simultaneously, caused by stone fragments migrating to the ureter, and high intrarenal pressures during surgery. Additionally, especially in elderly patients with comorbidities, the prone position may cause problems during or after the operation, such as reduced lung compliance, risk of endotracheal tube kinking, decreased cardiac output, reduced venous return, pressure damages (breast and lip necrosis) and ischemic accidents.[15] However, no cardiovascular or ischemic complication was observed in either group in this study. In the current study, two other factors were found to be predictive for complication development: stone size >25mm, and CCI score ≥2. Similarly, Turna *et al*. have reported that the total number of complications associated with increasing stone surface area.[23] In regard to the latter, CCI was also to be a predictive factor in a study by Unsal *et al*. evaluating the efficacy of CCI on PCNL to predict of morbidity and mortality.[24]

This study has some limitations. The first is its retrospective design. Second, CCI, an index designed to predict mortality using 19 comorbid conditions, was used to predict surgical complications, but not medical complications. The last limitation is the absence of long-term comparison of complications. There is a need for prospective studies with a larger series of geriatric patients.

CONCLUSION

Supine and prone mini-PCNL are equally acceptable, equally effective treatment modalities for elderly patients with renal stones. However, prone mini-PCNL had significantly longer fluoroscopy and hospitalisation time. There was no statistically significant difference in the overall complication rate, but significantly higher minor complication rate in the prone group. Stone size >25mm and CCI score ≥ 2 may be considered acceptable predictive factors for higher complication rates; therefore, for older patients with high CCI scores, supine mini-PCNL is a potentially safer treatment method.

ETHICAL APPROVAL:
This study follows the principles of the Declaration of Helsinki; and it was approved by the Ethics Committee of the University of Health Sciences, Bozyaka Training and Research Hospital, Izmir (Meeting/Decision No. 2021/174).

PATIENTS' CONSENT:
Informed consent was not obtained due to the retrospective nature of the study design.

CONFLICT OF INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
MS: Study conception and design, analysis and interpretation of data, wrote the paper.
SY: Study conception and design, wrote the paper.
OS: Acquisition of data, critical revision.
UC: Analysis and interpretation of data, statistical analysis.
FO: Analysis and interpretation of data, critical revision.

REFERENCES

1. Türk C, Petřík A, Sarica K, Seitz C, Skolarikos A, Straub M, *et al*. EAU guidelines on interventional treatment for urolithiasis. *Eur Urol* 2016; **69(3)**:475-82. doi: 10.1016/j.eururo.2015.07.041
2. Chung DY, Kang DH, Cho KS, Jeong WS, Jung HD, Kwon JK, *et al*. Comparison of stone-free rates following shock wave lithotripsy, percutaneous nephrolithotomy, and retrograde intrarenal surgery for treatment of renal stones: A systematic review and network meta-analysis. *Plos One* 2019; **14(2)**:e211316. doi: 10.1371/journal.pone.0211316.
3. Wollin DA, Preminger GM. Percutaneous nephrolithotomy: Complications and how to deal with them. *Urolithiasis* 2018; **46(1)**:87-97. doi: 10.1007/s00240-017-1022-x.
4. Lahme S. Miniaturisation of PCNL. *Urolithiasis* 2018; **46(1)**:99-106. doi: 10.1007/s00240-017-1029-3.
5. Proietti S, Rodríguez-Socarrás ME, Eisner B, Coninck VD, Sofer M, Saitta G, *et al.* Supine percutaneous nephrolithotomy: Tips and tricks. *Transl Androl Urol*. 2019; **8(Suppl 4)**:381-8. doi: 10.21037/tau.2019.07.09.
6. Gokcen K, Dundar G, Bagcioglu M, Karagoz MA, Gokce G, Sarica K. Safety and efficacy of RIRS in geriatric patients: A comparative evaluation on an age based manner. *Urol J* 2020; **17(2)**:129-33. doi: 10.22037/uj.v0i0.4921
7. Ozgor F, Yanaral F, Savun M, Ozdemir H, Caglar U, Sarilar O. Comparison of miniaturized percutaneous nephrolithotomy and flexible ureterorenoscopy for moderate size renal stones in elderly patients. *Kaohsiung J Med Sci* 2018; **34(6)**:352-6. doi: 10.1016/j.kjms.2017.10.003.
8. Hu H, Lu Y, He D, Cui L, Zhang J, Zhao Z, *et al.* Comparison of minimally invasive percutaneous nephrolithotomy and flexible ureteroscopy for the treatment of intermediate proximal ureteral and renal stones in the elderly. *Urolithiasis* 2016; **44(5)**:427-34. doi:

10.1007/s00240-015-0854-5.

9. Sahin A, Atsü N, Erdem E, Oner S, Bilen C, Bakkaloğlu M, *et al.* Percutaneous nephrolithotomy in patients aged 60 years or older. *J Endourol* 2001; **15(5)**:489-91. doi: 10.1089/089277901750299276.
10. Iqbal N, Hasan A, Malik HA, Khan R, Nazar A, Khawaja MA. A comparison of complications and success rates after PCNL in younger and elderly patients. *J Coll Physicians Surg Pak* 2020; **30(12)**:1316-20. doi: 10.29271/jcpsp.2020.12.1316.
11. Resorlu B, Diri A, Atmaca AF, Tuygun C, Oztuna D, Bozkurt OF, *et al*. Can we avoid percutaneous nephrolithotomy in high-risk elderly patients using the Charlson comorbidity index? *Urology* 2012; **79(5)**:1042-7. doi: 10.1016/j.urology.2011.10.060.
12. Hersey AE, Durand WM, Eltorai AEM, DePasse JM, Daniels AH. Longer operative time in elderly patients undergoing posterior lumbar fusion is independently associated with increased complication rate. *Global Spine J* 2019; **9(2)**: 179-84. doi: 10.1177/2192568218789117.
13. Falahatkar S, Moghaddam AA, Salehi M, Nikpour S, Esmaili F, Khaki N. Complete supine percutaneous nephrolithotripsy comparison with the prone standard technique. *J Endourol* 2008; **22(11)**:2513-7. doi: 10.1089/end.2008.0463.
14. Birowo P, Tendi W, Widyahening IS, Rasyid N, Atmoko W. Supine versus prone position in percutaneous nephrolithotomy: A systematic review and meta-analysis. *F1000Res* 2020; **9**:231. doi: 10.12688/f1000research.22940.3.
15. Cracco CM, Scoffone CM. ECIRS (endoscopic combined intrarenal surgery) in the galdakao-modified supine valdivia position: A new life for percutaneous surgery? *World J Urol* 2011; **29(6)**:821-7. doi: 10.1007/s00345-011-0790-0.
16. Okeke Z, Smith AD, Labate G, D'Addessi A, Venkatesh R, Assimos D, *et al.* Prospective comparison of outcomes of percutaneous nephrolithotomy in elderly patients versus younger patients. *J Endourol* 2012; **26(8)**:996-1001. doi: 10.1089/end.2012.0046.
17. Deiner S, Chu I, Mahanian M, Lin HM, Hecht AC, Silverstein JH. Prone position is associated with mild cerebral oxygen desaturation in elderly surgical patients. *PLoS One* 2014; **9(9)**:e106387. doi: 10.1371/journal.pone.0106387.
18. Ballard C, Jones E, Gauge N, Aarsland D, Nilsen OB, Saxby BK, *et al.* Optimised anaesthesia to reduce postoperative cognitive decline (POCD) in older patients undergoing elective surgery, a randomised controlled trial. *PLoS One* 2012; **7(6)**:e37410. doi: 10.1371/journal.pone.0037410.
19. Tokatli Z, Gokce MI, Süer E, Sağlam R. Supine or prone position for mini-PNL procedure: does it matter. *Urolithiasis* 2015; **43(3)**:261-4. doi: 10.1007/s00240-015-0758-4.
20. Yuan D, Liu Y, Rao H, Cheng T, Sun Z, Wang Y, *et al.* Supine *versus* Prone position in percutaneous nephrolithotomy for kidney calculi: A meta-analysis. *J Endourol* 2016; **30(7)**:754-63. doi: 10.1089/end.2015.0402.
21. Li J, Gao L, Li Q, Zhang Y, Jiang Q. Supine *versus* prone position for percutaneous nephrolithotripsy: A meta-analysis of randomised controlled trials. *Int J Surg* 2019; **66**:62-71. doi: 10.1016/j.ijsu.2019.04.016.
22. Anagnostou T, Thompson T, Ng CF, Moussa S, Smith G, Tolley DA. Safety and outcome of percutaneous nephrolithotomy in the elderly: Retrospective comparison to a younger patient group. *J Endourol* 2008; **22(9)**: 2139-45. doi: 10.1089/end.2007.0432.
23. Turna B, Umul M, Demiryoguran S, Altay B, Nazli O. How do increasing stone surface area and stone configuration affect overall outcome of percutaneous nephrolithotomy? *J Endourol* 2007; **21(1)**:34-43. doi: 10.1089/end.2005.0315.
24. Unsal A, Resorlu B, Atmaca AF, Diri A, Goktug HN, Can CE, *et al.* Prediction of morbidity and mortality after percutaneous nephrolithotomy by using the Charlson Comorbidity Index. *Urology* 2012; **79(1)**:55-60. doi: 10.1016/j.urology.2011.06.038.