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ORIGINAL PAPER

Kidney displacement in complete supine PCNL is lower than prone PCNL

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Abstract To compare the amount of the kidney displacement in the complete supine percutaneous nephrolithotripsy (PCNL) to the prone PCNL during getting renal access. Thirty-three patients were randomly divided into two groups. The patients in group A were placed in the complete supine position and the patients in group B in the prone position. Amounts of the kidney displacement in three states and other data were analyzed. The mean amount of the kidney displacement in the complete supine PCNL was 10.1 ± 7.9 mm in stage 1, 10.7 ± 8.28 mm in stage 2 and 12.2 ± 10.4 mm in stage 3. The mean amount of the kidney displacement in prone PCNL was 16.6 ± 5.8 mm in stage 1, 16.2 ± 6.3 mm in stage 2 and 17.6 ± 6.7 mm in stage 3. In stages 1 and 2, a significant difference between the two groups derived from the mean amount of the kidney displacement, but the difference was not statistically significant in stage 3. Adjusted for age, gender, BMI, stone burden and position of PCNL, prone position was a predictor caused significantly more displacement in all three stages. Among other predictors, only BMI had a significant effect on the amount of the kidney displacement (in stages 2 and 3). Performing PCNL in the complete supine position is safe and effective and leads to less kidney displacement during getting renal access and therefore, it may be considered in most patients requiring PCNL.

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Introduction

Percutaneous nephrolithotripsy (PCNL) is performed in four different positions: prone, modified supine, flank and complete supine position [1–4], but the approach that has been usually used is performing PCNL in the prone position [5]. This approach has some disadvantages including patient discomfort, circulatory and ventilator difficulties, especially in the obese [4]. There are concerns regarding prone approach in patients with compromised cardiopulmonary status and stature deformity [6]. In patients at high anesthesiologic risk, PCNL is performed in either the flank or a modified supine position [7].

Another new approach is performing PCNL in complete supine position that has been reported safe, effective and suitable for patients [2].

The supine position has several advantages. A change is not required from lithotomic to prone position during the procedure. Rapid access to the airway is possible in this position. In supine PCNL, the surgeon is more comfortable adopting a sitting posture during stone management [8].

One of the problems noticed in PCNL is kidney displacement during getting renal access.

Anteromedial movement of the kidney during dilation was noticed with the modified supine position [4], but in complete supine position kidney displacement to anterior is reported lower than the modified one [2].

Since getting renal access is one of the important steps in performing PCNL, we compared complete supine approach to prone, regarding to the amount of kidney displacement during getting access, and evaluated the effects of gender,

BMI, age and stone burden on the amount of kidney displacement.

On the basis of our knowledge, this is the first randomized study that compares the amount of kidney displacement in complete supine PCNL and prone position.

Materials and methods

Since April to September 2009, 33 patients were randomly divided into 2 groups: Group A (18 patients, complete supine position); and Group B (15 patients, prone position).

In Group A, the patients underwent PCNL in the complete supine position without flank elevation, there was not any rolled towel under the flank and there was no change in leg position.

The inclusion criteria were renal stone $\geq$2 cm in diameter, stone size $\geq$1.5 cm in lower calyx and stones resistant to ESWL $\geq$1 cm and no contraindication to perform PCNL in the prone position.

The exclusion criteria were renal anomalies, uncontrolled coagulopathy, pregnancy, immunosuppression, history of previous PCNL and retroperitoneal surgery.

We believe that the main effective factor on the kidney displacement is previous renal or retroperitoneal surgery.

Institutional review board approval was obtained before undertaking the study. Informed consent was obtained from all patients before considering them for the study.

The blocked randomization schedule was used to allocate the patients. Only the surgeon was aware of PCNL type and the analyst were unaware of the treatment allocation.

Data including age, gender, weight, height and stone diameter [based on ultrasonographic and intravenous urogram (IVU) findings] were recorded in all of the patients before the operation. Stone burden was defined as the maximum diameter of the stone on IVU or ultrasonography.

We were defined hydronephrosis on the basis of IVU or ultrasonography (mild, moderate and severe).

Preoperative evaluation included laboratory tests, renal ultrasonography (US), plain radiography and IVU. Before PCNL, urine cultures were obtained, and if positive, the appropriate antibiotics were administered. We used general anesthesia for all the patients.

We placed ureteral catheter for opacification or saline injection. Then the patients in group A were placed in complete supine position without flank elevation and the patients in group B placed in prone position. There was not any rolled towel under the flank and there was no change in leg position in group A.

Percutaneous access was performed under fluoroscopic guidance. Our access was subcostal. We achieved collecting system puncture by 18 gauge needle.

Return of urine on removal of stylet of needle confirmed entrance into the collecting system.

Then, a 0.035-in. J-tip guide wire was inserted. The access to the kidney was dilated by one shot dilation. Dilation was performed by a 9Fr dilator. Then a single 28Fr Amplatz dilator was pulled in the alkan guide. This single passage allowed insertion of the 30F Amplatz working sheath [2].

For measuring the amount of kidney displacement we used the method below:

A transparent graph paper (covered in 5×5 mm squares) was placed on the monitor of fluoroscope before starting every prone or supine PCNL operation.

We asked our co-workers to record all steps of procedure on the monitor of fluoroscope.

Changes in the location of the kidney in fluoroscopic monitor were recorded by a digital video recorder camera, all along the access time, from the first step to the end.

We described the kidney movement, while getting access, into three different stages:

The kidney displacement in stage 1 When the 18 gauge needle had moved the kidney, it was recorded as the initial point and after the entrance of the needle to the calyx, it was recorded as the final point.

The kidney displacement in stage 2 When the 9Fr dilator had moved the kidney, it was recorded as the initial point, and after the entrance of the needle to the calix, it was recorded as the final point.

The kidney displacement in stage 3 When the 28Fr Amplatz dilator had moved the kidney, it was recorded as the initial point, and after the entrance of the needle to the calix, it was recorded as the final point.

Measurement of the kidney displacement in all three stages was performed using the same method in both of the groups (in mm).

The stone-free rate and complications such as urine leakage, transfusion, fever and arterial fistula were recorded in all patients. On the first postoperative day and 2 weeks after the operation, a plain radiography was performed to detect stone-free rates. Postoperative ultrasonography was performed to detect radiolucent stones and any complications, 2 weeks after the operation. Stone-free rate was defined residual stones less than 5 mm [1].

Statistical analysis

For assessing normality of kidney displacement as a dependent variable we used Kolmogrov–Smirnov test.

We used nonparametric (Mann–Whitney) test for asymmetric variables. Linear regression analysis was performed using amount of displacement as the dependent variable, and age, gender, BMI, stone burden and position of PCNL as predictors. Data were analyzed using SPSS 16.0 software. P value <0.01 was considered significant.

Table 1 Patient characteristics and intra- and postoperative parameters

	Group A (supine position)	Group B (prone position)	*P* value
Total patients	18	15	
Male-to-female ratio	15/3	10/5	0.27
Mean age (year)	49.9	47.06	0.44
BMI (kg/m^2)	26.9	24.8	0.08
Mean stone burden, diameter (mm)	31.2	27.3	0.35
Stone-free rate (%)	77.8	80	0.88
Mean hospital stay (day)	2.7	3.1	0.06
Complications			
Fever >38°C	5.6	20	0.21
Transfusion	5.6	6.7	0.89
Arterial fistula	0	0	
Urine leakage	0	0	
Pleural effusion (*n*)	0	0	
Colon injury (*n*)	0	0	
DVT (*n*)	0	0	
Mortality (*n*)	0	0	
Conversion to open surgery (*n*)	0	0	

Results

There were 15 (83.3%) male and 3 (16.7%) female with the mean age of 49.9 ± 12.4 and the mean BMI of 26.9 ± 3.4 in group A (complete supine position). In group B (prone position), 66.7% were male and 33.4% were female with the mean age of 47.06 ± 7.5 and the mean BMI of 24.8 ± 3.07. The mean stone burden in the complete supine and the prone position was 31.2 ± 14.5 and 27.3 ± 6.9 mm, respectively. There was no significant statistical difference between two groups regarding to gender, age, and BMI and stone burden.

According to the world health organization (WHO) classification of body mass index (BMI), BMI 18.5–24.99 kg/m^2 were considered normal range and BMI 25–29.99 were considered overweight [9]. In this study, the mean BMI of group A patients was in normal range but in group B patients was overweight, but the difference between the two groups was not statistically significant (*P* value 0.08).

Mean hospital stay in the complete supine and the prone group was 2.7 ± 0.75 and 3.1 ± 0.35 days, respectively, without any significant statistical difference (*P* value 0.06).

There was not any major complication in our patients, but two patients [1 (5.6%) in the complete supine and 1 (6.7%) in the prone position] had bleeding required transfusion.

Fever rate was 5.6 and 20% in group A and B, respectively.

Stone-free rate was 78% in group A and 80% in group B.

The patient characteristics and intra and postoperative parameters are summarized in Table 1.

Table 2 Mean amounts of kidney displacement in the two study groups

Mean amount of kidney displacement	Group A (supine position)	Group B (prone position)	*P* value
Stage l (mm)	10.1 ± 7.9	16.6 ± 5.8	0.004
Stage 2 (mm)	10.7 ± 8.8	16.2 ± 6.3	0.01
Stage 3 (mm)	12.2 ± 10.4	17.6 ± 6.7	0.57

In our study, the mean amount of kidney displacement in stage 1 was 10.1 ± 7.9 mm in group A and 16.6 ± 5.8 mm in group B (*P* value <0.004).

The mean amount of kidney displacement in stage 2, in group A and B was 10.7 ± 8.28 and 16.2 ± 6.3 mm, respectively (*P* value 0.01).

In stage 3, the mean amount of the kidney displacement was 12.2 ± 10.4 mm in group A and 17.6 ± 6.7 mm in group B (*P* value 0.57).

The kidney displacement in stage 1 and 2 had a significant difference between two groups, but the difference was not statistically significant in stage 3.

The mean amounts of the kidney displacement in groups A and B are demonstrated in Table 2.

Table 3 presents the results of the multiple linear regression analysis.

The prone position has caused significantly more displacement in all three stages, but it did not prohibit getting access.

The amount of the kidney displacement caused by the prone position (compared to the complete supine position)

Table 3 Relationship between study variables and the amounts of displacement by linear regression

	β coefficient (SE)		
	Stage 1	Stage 2	Stage 3
Position of PCNL (prone)	7.75 (2.6)*	7.35 (2.3)*	8.9 (2.9)*
Gender (female)	3.9 (2.8)	6.5 (2.5)	2.1 (3.2)
Age (year)	0.02 (0.1)	0.16 (0.1)	0.06 (0.1)
BMI (kg/m^2)	0.63 (0.4)	1.04 (0.3)*	1.6 (0.4)*

SE standard error

* *P* value <0.01

was 7.75 mm in stage 1 (*P* value 0.006), 7.35 mm in stage 2 (*P* value 0.004) and 8.9 mm in stage 3 (*P* value 0.005). BMI was a predictor caused significantly more displacement in stages 2 and 3, but it had no significant statistical effect on the amount of the kidney displacement in stage 1.

Neither age and gender, nor stone burden variables were significant predictors of the kidney displacement (*P* value 0.1).

Discussion

Percutaneous nephrolithotripsy (PCNL) has proved its efficacy in the treatment of renal stones and other related renal diseases [2, 10–16].

Although supine PCNL has numerous advantages and is routinely used in some surgical centers throughout the world, its popularity is still minimal in the field of urology as a whole. This general lack of acceptance most likely stems from fear of colonic injury during this procedure and from a lack of training in this position from educational centers [17].

Stone-free rate

In this study the stone-free rates were 80 and 77.8% in group A and B, respectively, with no significant difference.

In Shoma et al. [4] study, stone-free rates were reported 89 versus 84% for supine and prone positions, respectively.

In De sio et al. study stone-free rate was 88.7% in supine position versus 91.6% in prone position (*P* value 0.1). Their stone-free rate was higher than that reported by others. They mentioned that it might be due to excluding complete staghorn stones, stones requiring multiple percutaneous renal access and renal anomalies [14].

In another study, stone-free rates were 80 versus 77.5% in prone and supine positions, respectively, with no significant statistical difference [2].

Hospital stay

The mean hospital stay reported by Shoma et al. [4] was 2.5 and 2.7 days for supine and prone position, respectively. In De sio et al. study, the mean hospital stay was 4.3 days in supine position versus 4.1 days in prone position [14].

In Neto et al. [1] study, the mean hospital stay was 5.4 days. In the study that compared complete supine position to prone position for the first time, the mean hospital stays were 80.02 and 73.2 h for complete supine and prone position, respectively [2].

In our study, there was no significant statistically difference between complete group A and B, respectively, regarding the mean hospital stay. It was 2.7 days in group A and 3.1 days in group B.

Complications

The reported complication rate during PCNL ranges from 3 to 18% [11, 18–20].

Bleeding rate in several studies was reported 5–20% in the supine position [2, 4].

In our study, the transfusion rate was 5.6% in group A and 6.7% in group B (*P* 0.89).

The difference was not statistically significant and remained within the reported range in published studies [18, 21–23].

The risk of blood transfusion after PCNL is influenced by many factors including operative technique, patient status and stone complexity. The number of punctures has also been incriminated in the occurrence of vascular injuries in some series [11, 24].

In our study, one patient (5.6%) in group A and three patients (20%) in group B had fever; therefore, fever rate was higher in group B but the difference was not statistically significant.

The higher fever rate in the prone procedure may be related to longer operative time and the position of the patient that it was increased some complications like atelectasia.

The frequency of fever after PCNL was reported 25.8% [25]. Fever rate was 4% in supine and 5% in prone position, in Shoma et al. [4] study.

Neto et al. [1] reported that 13.6% of patients (who underwent PCNL in modified supine position) had fever.

Computed tomography examinations demonstrated that the risk of colonic injury might be greater in prone position and in the supine position the colon was more distant from the kidney than in the prone position [7, 26].

In another study, only 2% of the patients had a retrorenal colon in supine position, which subsequently increased to 10% when they were turned to prone position [27, 28].

Other studies demonstrated the safety of the supine position regarding the possibility of colonic trauma [2, 4].

In our study, no patient had a colonic injury and there was not any other complication such as pleural effusion, deep vein thrombosis and arterial fistula.

Since, in the supine position the displacement of colon to anterior is more than that in the prone position, it floats away from the kidney and it would be less likely to be injured [7, 17].

Kidney displacement

On the basis of our knowledge, this is the first study for measuring the amount of the kidney displacement during getting access in PCNL.

In Shoma et al. study, anteromedial movement of the kidney during dilation was noticed with the supine position. However, the pelvicaliceal system could be safely approached in all cases. Extra-abdominal compression was applied during dilation to minimize renal movement. In their study, for supine PCNL, the patient was placed in the supine position with a water bag below the ipsilateral flank, thus the flank was elevated 20° [4].

In the study for comparing complete supine to prone position, patients were placed in a complete supine position without flank elevation, there was not any rolled towel under the flank and there was no change in leg position. The kidney displacement to anterior was lower in complete supine position compared to the modified one [2]. The amount of kidney displacement was measured in none of these studies.

We measured the amount of the kidney displacement in three stages. The mean amount of the kidney displacement in the complete supine PCNL was 10.1 ± 7.9 mm in stage 1, 10.7 ± 8.28 mm in stage 2 and 12.2 ± 10.4 mm in stage 3. The mean amount of the kidney displacement in the prone PCNL was 16.6 ± 5.8 mm in stage 1, 16.2 ± 6.3 mm in stage 2 and 17.6 ± 6.7 mm in stage 3.

In stages 1 and 2, a significant difference between the two groups derived from the mean amounts of the kidney displacement, but the difference was not statistically significant in stage 3.

Since in stage 3, the 28Fr Amplatz dilator pulled on the alkan guide, the kidney would be rather fixed by the alkalen, in both of the prone and the complete supine positions and therefore the effect of the position on the amount of displacement might be eliminated in this stage.

High standard deviations could be due to the small sample volume and asymmetric data distribution and it could be a limitation of our study.

We evaluated the amount of the kidney displacement on the monitor of fluoroscope. Actually it was not the real kidney movement in the retroperitoneal space, because the monitor has two dimensions but the kidney is lying in a space with three dimensions, and although we measured the displacement in a two-dimensional surface, the method was the same for all cases in a way that a kidney movement on a two-dimensional surface was compared to another kidney movement on the same surface.

The amounts of the kidney displacement during getting access in PCNL were lower in the complete supine position. Kidney is in its own anatomic location when the patient is placed in the complete supine position, and it could be a reason. In our study, more displacement was not a factor to prevent gaining renal access. There was no case of conversion to open surgery.

It is clear that obesity plays a role in the various methods of stone treatment, and there are many studies that evaluated the safety and outcome of PCNL in obese patients [29, 30]. In the other study, there was non-significant difference in outcome or morbidity between obese and no obese patients [30].

For obese patients and staghorn calculi, prone PCNL appears to be associated with decreased operative times with similar bleeding rates and slightly better stone-free rates than supine PCNL [31].

Although gaining access to the pelvicaliceal system can be more difficult in obese patients [15], the outcome of PCNL seems to be independent of the patient's BMI. El-Assmy et al. [30] reported that PCNL in obese and morbidly obese patients had a complication rate and hospital stay similar to those achieved in non obese populations.

To best of our knowledge, our study is the first study that evaluates the effect of BMI, as a predictor, on the difficulty of getting access in PCNL. We noted that the amount of the kidney displacement was influenced by the increase in the patient's BMI (as an independent predictor), in stages 2 and 3.

We guess that in patients with high BMI, there are abundant of fat in retroperitoneal cavity and around the kidney that increases the possibility of the kidney movement, although we did not evaluate this factor.

Although the displacement would not prevent gaining access, it could make it rather difficult.

The kidney displacement may cause 18-gauge needles or dilatators to be placed in the wrong way and lead to prolonged problematic surgery, adjacent organ damage and postoperative complications.

In the present study, we compared the amount of the kidney displacement and outcome of the complete supine PCNL to the prone PCNL.

In this study, the number of patients was small and more studies are needed to improve it.

The amount of displacement was lower in the complete supine position (in stages 1 and 2). There was not any

significant difference between these two groups, regarding to stone-free rate, hospital stay and complication rate.

Conclusion

Performing PCNL in the complete supine position is safe and effective; and lead to less kidney displacement during getting renal access and therefore, it may be considered for most patients requiring PCNL.

Although supine PCNL has numerous advantages and is routinely used in some surgical centers throughout the world, its popularity is still minimal in the field of urology as a whole. This general lack of acceptance is most likely because of fear of colonic injury during this procedure and from a lack of training in this position from educational centers. This study is preliminary and it should be emphasized that any conclusion regarding the amounts of the kidney displacement and its possible effects can be drawn from further studies with more cases.

We think that the lower amounts of the kidney displacement in csPCNL are related to these factors: the weight of intraperitoneal organs like liver and spleen or colon on the kidney and the gravity of the kidney in normal anatomic position.

References

1. Neto EAC, Mitre AI, Gomes CM et al (2007) Percutaneous nephrolithotripsy with the patient in a modified supine position. J Urol 178(1):165–168
2. Falahatkar S, AfshariMoghaddam A, Salehi M et al (2008) Complete supine percutaneous nephrolithotripsy comparison with the prone standard technique. J Endourol 22(10):2513–2517
3. Karami H, Arab A, Rezaei A et al (2009) Percutaneous nephrolithotomy with ultrasonographyguided renal access in the lateral decubitus flank position. J Endourol 23(1):33–36
4. Shoma AM, Eraky I, El-kenawy MR et al (2002) Percutaneous nephrolithotomy in the supine position: technical aspects and functional outcome compared with the prone technique. Urology 60(3):388–392
5. Cormio L, Annese P, Corvasce T et al (2007) Percutaneous nephrostomy in supine position. J Urology 69(2):377–380
6. Manohar T, Jain P, Desai M (2007) Supine percutaneous nephrolithotomy: effective approach to high-risk and morbidly obese patients. J Endourol 21(1):44–49
7. Valdivia Uria JG, Valle Gerhold J, Lopez JA et al (1998) Technique and complications of percutaneous nephroscopy: experience with 557 patients in the supine position. J Urol 160:1975–1978
8. Ng MT, Sun WH, Cheng CW, Chan ES (2004) Supine position is safe and effective for percutaneous nephrolithotomy. J Endourol 18:469–474
9. World Health Organization (2000) Obesity: Preventing and managing the global epidemic. Report of a WHO Consultation (WHO Technical Report Series 894). World Health Organization, Geneva
10. Rana AM, Bhojwani JP, Junejo NN et al (2008) Tubeless PCNL with patient in supine position: procedure for all seasons with comprehensive technique. Urology 71(4):581–585
11. El-Assmy AM, Shokeir AA, Mohsen T et al (2007) Renal access by urologist or radiologist for percutaneous nephrolithotomy-is it still an issue? J Urol 178:916–920
12. Preminger GM, Assimos DG, Lingeman JE, Nakada SY, Pearle MS, Wolf JS Jr (2005) Chapter 1: AUA guideline on management of staghorn calculi: diagnosis and treatment recommendations. J Urol 173:1991
13. Ramakumar S, Segura JW (2000) Renal calculi: percutaneous management. Urol Clin North Am 27:617–622
14. De Sio M, Autorino R, Quarto G et al (2008) Modified supine versus prone position in percutaneous nephrolithotomy for renal stones treatable with a single percutaneous access: a prospective randomized trial. Eur Urol 54:196–203
15. Gofrit ON, Shapiro A, Donchin Y et al (2002) Lateral decubitus position for percutaneous nephrolithotripsy in the morbidly obese or kyphotic patient. J Endourol 200216(6):383–386
16. Basiri A, Ziaee SAM, Nasseh H et al (2008) Totally ultrasonography-guided percutaneous nephrolithotomy in the flank position. J Endourol 22(7):1453–1457
17. Falahatkar S, Allahkhah A (2010) Recent developments in percutaneous nephrolithotomy: benefits of the complete supine position. Uro Today Int J 3(2)
18. Segura JW, Patterson DE, LeRoy AJ et al (1985) Percutaneous removal of kidney stones: review of 1,000 cases. J Urol 134:1077–1081
19. Lee WJ, Smith AD, Cubelli V, Badlani GH, Lewin B, Vernace F et al (1987) Complications of percutaneous nephrolithotomy. Am J Roentgenol 148:177–180
20. Tefekli A, Karadag MA, Tepeler K et al (2008) Classification of percutaneous nephrolithotomy complications, using the modified clavien grading system: looking for a standard. Eur Urol 53:184–190
21. El-Kenawy MR, El-Kappany HA, El-Diasty TA et al (1992) Percutaneous nephrolithotomy for renal stones in over 1,000 cases. Br J Urol 69:470–475
22. Jones DJ, Russel GL, Kellett MJ et al (1990) The changing practice of percutaneous stone surgery: review of 1,000 cases 1981–1988. Br J Urol 66:1–5
23. Lingeman JE, Coury TA, Newman DM et al (1987) Comparison of results and morbidity of percutaneous nephrolithotomy and extracorporeal shock wave lithotripsy. J Urol 138:485–490
24. Patterson DE, Segura JW, LeRoy AJ, Benson RC, May GR (1985) The etiology and treatment of delayed bleeding following percutaneous lithotripsy. J Urol 133:447
25. Sharifi AF, Akhavizadegan H, Aryanpoor A, Inanloo H, Karbakhsh M et al (2006) Fever after percutaneous nephrolithotomy: contributing factors. Surg Infect (Larchmt) 7:367–371
26. Tuttle DN, Yeh BM, Meng MV et al (2005) Risk of injury to adjacent organs with lower-pole fluoroscopically guided percutaneous nephrostomy: evaluation with prone, supine, and multiplanar reformatted CT. J Vasc Interv Radiol 16:1489–1492
27. LeRoy AJ, Williams HJ Jr, Bender CE et al (1985) Colon perforation following percutaneous nephrostomy and renal calculi removal. Radiology 155:83–85
28. Hopper KD, Sherman JL, Luethke JM et al (1987) The retrorenal colon in the supine and prone patient. Radiology 162:443–446
29. Sergeyev I, Koi PT, Jacobs SL et al (2007) Outcome of percutaneous surgery stratified according to body mass index and kidney stone size. Surg Laparosc Endosc Percutan Tech 17:179–183
30. El-Assmy AM, Shokeir AA, El-Nahas AR et al (2007) Outcome of percutaneous nephrolithotomy: effect of body mass index. Eur Urol 52:199–205
31. de la Rosette JJMCH, Tsakiris P, Ferrandino MN et al (2008) Beyond prone position in percutaneous nephrolithotomy: a comprehensive review. Eur Urol 54:1262–1269