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Comparison of the Modified Lateral Position and Prone Position Techniques in Percutaneous Nephrolithotomy

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ABSTRACT
Objectives: To evaluate the feasibility, operative time, efficacy and safety of the modified lateral position in percutaneous nephrolithotomy (PCNL) for renal calculi, comparing it with the standard prone position PCNL. **Material and Method:** The patient is placed with the thorax in the lateral position and the pelvis in an oblique position. Then the lower limbs are split and bent in the lowest position. Initial placement of a retrograde ureteral catheter, tract formation, stone fragmentation and retrieval, and optional extra procedures were accomplished with the patient in the same position. **Results:** The study comprised 82 patients; 29 in split-leg modified lateral position (SL-MLP) group and 53in conventional prone position (PP) group. Three patients (all in PP group) underwent sequential bilateral percutaneous nephrolithotomy (PNL) during the study period and each procedure was considered as an independent case. So, the studied cases, according to the number of PNL procedures, were 85; 29 in SL-MLP group and 56 in PP group. **Conclusions:** split-leg modified lateral position in percutaneous nephrolithotomy (SL-MLP PNL) has significantly lower operative time compared with conventional PP PNL. The stone free rate, need for ancillary procedures and complication rate were equal in both groups.

Keywords: Prone position, modified lateral position, percutaneous nephrolithotomy.

INTRODUCTION

With the introduction of new technologies in endourology, the indications for open surgery for urolithiasis have decreased considerably. Minimal invasive treatment or surgery has become increasingly popular since its reduction in patient's morbidity and period of convalescence [1].

Following the first description of percutaneous renal access with a patient in the prone position (PP) by **Goodwin *et al.*** [2]; **Fernstrom and Johansson** [3] reported the first case of stone extraction through a nephrostomy tract in 1976. Since then, percutaneous nephrolithotomy (PNL) has been widely accepted and its indications well codified.

Variations of the PNL technique, including mini-PNL, ultra-mini-PNL and tubeless-PNL, have been described with the aim of reducing patients' morbidity.

There is still controversy over the optimal position and technique to perform PNL, and an overall consensus has yet to be reached. Since it was initially described, the PP has been the most commonly used position for PNL [4-6]. However, this position does have some drawbacks; it might be risky for patients with cardiopulmonary ailments and markedly obese patients [7, 8]. In addition, the change of position from supine to prone is really a time-consuming procedure to perform carefully and has a certain potential for complications, because of the risk of neck or limb injury or dislodgement of the endotracheal tube. Moreover, simultaneous antegrade and retrograde access to the upper urinary tract is difficult or even impossible without changing position [4, 6].

The rising number of PNL procedures combined with increasing confidence and experience has caused researchers to modify the prone technique in an effort to improve success rate and overcome some limitations. Some positions have been reported, aiming to overcome the drawbacks of PP, such as supine and modified supine positions, and lateral and modified lateral positions (MLP) [4-6, 9-11].

To date, several randomized controlled trials have been performed to compare the prone and supine position techniques during PNL and most of published data have not shown significant superiority of either approach [12].

Some investigators evaluated the split-leg MLP technique during PNL and concluded that this position has several advantages for the patient and the urologist, with greater versatility of stone manipulation along the entire urinary tract. However, there are no prospective

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randomized studies that compare the PP and MLP in PNL in the international literature.

Patients and Methods:

All PNL procedures were performed under general anesthesia.

The modified lateral position (MLP) technique: (Figure 1) Initially, the thorax was blocked with Elastoplasts band, with the patient in the lateral position perpendicular to the operating table. Second, the pelvis was placed in an oblique position at 45° by placing a rolled towel under the ipsilateral gluteus. Finally, the lower limbs are split and bent in the lowest position. The C-Arm head was tilted. From the beginning, the anesthetized patient was placed in this position, which was maintained throughout the whole procedure without change.

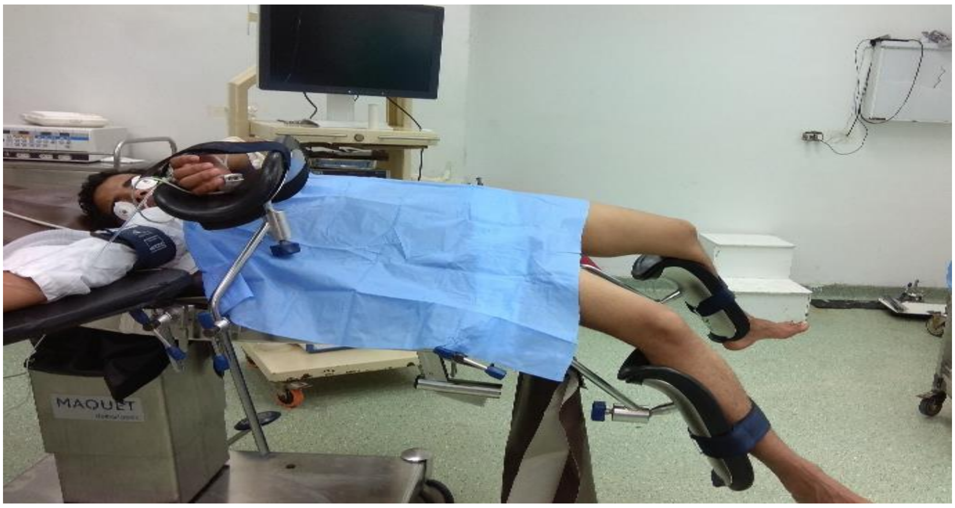

Figure (1): Modified lateral positioning during percutaneous nephrolithotomy

The prone position technique: Initially, the ureteric catheter was fixed with the patient in the lithotomy position. Then, the patient was turned prone for PNL. The targeted calyx was decided according to the retrograde pyelography and renal access was established under fluoroscopic guidance. In all cases: Metal Alken dilators were used for percutaneous tract formation. Peumatic lithotriptor was used for stone fragmentation. A nephrostomy tube was placed in the percutaneous tract at the end of the procedure.

RESULTS

The study comprised 82 patients; 29 in SL-MLP group and 53 in conventional PP group. Three patients (all in PP group) underwent sequential bilateral PNL during the study period and each procedure was considered as an independent case. So, the studied cases, according to the number of PNL procedures, were 85; 29 in SL-MLP group and 56 in PP group.

The study was conducted aiming to evaluate the feasibility, efficacy and safety, of the SL-MLP PNL compared with conventional PP PNL as standard control.

Sample size was calculated and stratified randomization was performed according the Guy’s score grades (with exclusion of grade 4), with an allocation ratio of 1 “SL-MLP”: 2 “PP” to reduce number of allocated cases in SL-MLP group. Eighty-five cases completed the study protocol; 29 in the SL-MLP group and 56 in PP group.

The demographic data, clinical characteristics, stone characteristics, operative parameters, stone free rate, post-operative parameters, hospital stay and need for ancillary procedures were evaluated and compared between both groups.

There were 57 (67.1%) males and 28 (32.9%) females; ranging in age from 18 to 63 years (mean: 46.38±10.86 years). The PNL procedure was performed on the right kidney in 72 (84.7%) and on the left kidney in 44 (51.8%).

The stone size ranged from 14.00 to 45.00 mm (mean: 31.14±7.15). the stone density ranged from 500 to 1600 HU (mean: 1026.56±427.91 HU).

The demographic data, base line clinical and stone characteristics were comparable between both groups.

In all cases, renal access was performed under fluoroscopy guidance, after retrograde endoscopic fixation of ureteric catheter. In SL-MLP, the ureteric catheter was inserted with the patient in the same position. Failed ureteric catheterization was reported in only one case in SL-MLP group and percutaneous access failure was reported in one case in PP group. Most of patients received subcostal lower pole access (47.1%); and only 3 patients in SL-MLP group and 5 in PP group required 2 punctures. Access tracks and number of punctures were comparable between both groups.

The overall operative time ranged from 35.00 to 130.00 minutes (mean: 83.41±24.75 minutes). SL-MLP group had a shorter operative time than PP-PNL group (mean: 55.52±21.27 versus 97.86±9.11 minutes) (p <0.001).

The track formation time ranged from 5.00 to 20.00 minutes (mean: 7.02±2.74 minutes) and the fluoroscopy time ranged from 2.00 to 6.00 minutes (mean: 3.58±1.25 minutes). The track formation time was longer in SL-MLP group (mean: 7.97±5.83 versus 6.54±1.86 minutes) (p = 0.0100, while the fluoroscopy time was comparable between both groups.

Intra-operative bleeding required blood transfusion was reported in 13 (15.3%) cases; 4 (13.8%) in SL-MLP group and 9 (15.5%) in PP-PNL group. However, only 3 (all in PP-PNL group) required pre-mature termination of PNL procedure due to intra-operative bleeding. No significant difference between split leg MLP group and PP group regarding intra-operative bleeding requiring blood transfusion or the need for procedure termination due to brisk hemorrhage.

Double-J ureteral stenting was required in 15 patients (5 in SL-MLP group and 10 in PP group). No significant difference was observed between both SL-MLP and prone position groups regarding the frequency of intra-operative double-J ureteral stenting (17.2% versus 17.9%, respectively).

Retrograde double-J ureteral stenting was performed in 9 cases; the 5 cases of SL-MLP group with the patient in the same position and 4 cases in PP group (after patients' re-positioning into lithotomy position). Antegrade double-J stenting was performed in 6 cases in PP group (with the patient in the PP).

The overall SFR was 75.3%; 21 (72.4%) patients in SL-MLP group and 43 (76.8%) in PP-PNL group after the primary PNL procedures. No significant difference was observed between both group regarding the SFR.

Four patients (all in PP-PNL group) required post-operative blood transfusion. The overall complication rate was 41.2%; 37.9% in SL-MLP group and 42.9% in PP group. The most common intra-operative complication was perforation of P/C system (7.1%; 10.3% in split-leg position group and 5.4% in PP group). The most common post-operative complication was fever (15.3%; 17.2% in split-leg position group and 14.3% in PP group). Colonic injury and subsequent death was reported in one case in PP group.

Operative Time:

The mean overall operative time was 83.41±24.75 minutes (range: 35.00 to 130.00 minutes). The operative time was significantly lower in SL-MLP group (55.52±21.27; range: 35 to 130 minutes) compared to PP group (mean: 97.86±9.11; range: 85.00 to 110.00 minutes) (p<0.001). The operative time of both groups are demonstrated in Figure 2.

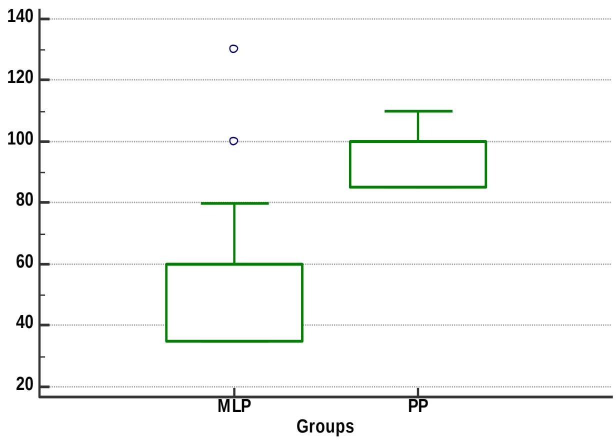

Figure (2): Box-and-Whisker plot demonstrating the operative time in both groups.

Stone Free Rate(SFR) and Ancillary Procedures:

The overall SFR was 75.3%; 21 (72.4%) patients in SL-MLP group and 43 (76.8%) in PP group were rendered stone free after the first PNL procedure. No significant difference was observed between both group regarding the SFR (p=0.658) (Table 1).

Second look PNL was done in 5 cases, one in SL-MLP group and 4 in PP group. Two of them (all in PP group) were stone free after the second look PNL.

Ancillary SWL was done in 18 cases, 6 in SL-MLP group and 8 in PP group (no data available about the outcome of shok wave lithotripsy (SWL).

Table (1): Stone free rate and ancillary procedures, overall and in both groups.

Variables	Overall (n=85)	SL-MLP (n=29)	PP (n=56)	p value
Stone free rate	64 (75.3)	21 (72.4)	43 (76.8)	0.658
No stone	54 (84.4)	18 (85.7)	36 (83.7)	
CIRF	10 (15.6)	3 (14.3)	7 (16.3)	
PNL failure	1 (1.2)	1 (3.4)	0 (0.0)	0.341
Ancillary procedures				
Re-look PNL	5 (5.9)	1 (3.4)	4 (7.1)	0.657
SWL	15 (17.6)	6 (20.7)	9 (16.1)	0.596

Data presented as number (%).
CIRF, Clinically insignificant residual fragment; PNL, percutaneous nephrolithotomy; SWL, shockwave lithotripsy

DISCUSSION

Positioning for PNL is an important, yet often neglected, aspect of the procedure. PNL is traditionally performed with the patient in the prone position (PP) [13]**.** Although percutaneous nephrolithotomy (PNL) is still mostly performed in PP, repositioning of the patients to PP is less attractive to urologists [14]**.**

A variety of advantages and disadvantages have been attributed to prone position percutaneous nephrolithotomy (PP PNL). It is well-known to urologists, access to the P/C system and nephroscope manipulation is easier in this position, operation field is wider, and instrument excursion is unlimited [1]**.**

However, repositioning of the patients from supine to prone may increase the risk of anesthetic complications. Turning a patient to prone has predictable effects on the cardiovascular system, especially the decrease in cardiac output [15]**.** In a study of 16 patients with cardiovascular disease, the PP was associated with a mean 24% decrease in the cardiac index [16]**.** Access to central veins is difficult, and if cardiopulmonary resuscitation or defibrillation is required, turning the patient to supine position is necessary [13]**.** Operators invariably become wedded to one position, yet with knowledge and experience of other positions, there is the freedom to choose the most appropriate technique for the case at hand. Modified PCNL positions were suggested to overcome such disadvantages, with the purpose of simplifying patient positioning and improving the efficacy of the procedure, including the lateral decubitus position [17-19]**,** modified lateral [9]**,** reverse lithotomy [20]**,** split-leg [21, 22]**,** and supine [23]**;** however, most of these have not gained widespread acceptance.

Flank [17] and Supine [23] positions are two frequent alternatives that have been shown to be safe and effective if compared with conventional prone PNL. PNL in supine position is less time-consuming for positioning the patient. If compared with the PP, PNL with the patient in the supine position has been reported to save 30 - 40 minutes of operation time [24]**.** Other advantages are spontaneous stone fragment evacuation with irrigation, more comfort for the patient and the surgeon [25]**,** easier simultaneous ureteroscopic access [14]**,** and lower radiation exposure to surgeon's hands [26]**.** Supine position is more comfortable for patients with cardiovascular and respiratory problems and severe musculoskeletal deformities [27]**.**

The disadvantages of PNL in supine position include more difficult approach to the upper pole than in the PP [25] and its association with higher risk of anterior calyx puncture. Also, when supine, the kidneys are more medial and have greater mobility in the retroperitoneum [24]**.** These two factors can make renal access more challenging. Furthermore, tract length is invariably longer. In obese patients, this may lead to the use of extra-long equipment, increased technical complexities, and higher costs. A longer access tract also decreases nephroscope mobility. Thus, more torque must be exerted on the renal parenchyma to maneuver the nephroscope that in turn it may increase blood loss [25]**.**

In 2011, **Lezrek *et al.*** [11] developed a new approach modifying the lateral position; termed split-leg (SL) MLP. In which the patient was placed with the thorax in the lateral position and the pelvis in an oblique position. Then the lower limbs were split and bent in the lowest position. Initial placement of a retrograde ureteral catheter, tract formation, stone fragmentation and retrieval, and optional extra procedures were accomplished with the patient in the same position. They found that PNL in the SL-MLP resulted in decreased operating room time, less manipulation of the anesthetized patient, and maintaining the sterility of the retrograde ureteral catheter. In addition, it allowed simultaneous antegrade and retrograde endoscopic approach to the upper urinary tract. Ureteral catheter placement, PNL, and associated procedures, e.g. internal urethrotomy, transurethral resection of the prostate, rigid and flexible URS, and endopyelotomy were possible in all patients. They concluded that, "performing PNL in the SL-MLP has several advantages for the patient and the urologist, with greater versatility of stone manipulation along the entire urinary tract". Despite **Lezrek *et al.*** **[11]** study aimed to demonstrate the feasibility and safety of SL-MLP in managing renal calculi without the disadvantages of other positions, lack of standard control for comparison is a major limitation of the study.

In the present study, we prospectively compared the SL-MLP technique, as described by **Lezrek *et al.*** **[11],** with the classic PP technique as standard control. The procedures were evaluated in terms of stone free rate, overall operative time, track formation time, fluoroscopy time, need for ancillary procedures and hospital stay.

In our study, 1" SL-MLP": 2 "standard PP" allocation was performed considering the complexity of the stone burden as well as the patient's anatomy. Guy's stone score was used for stratification after exclusion of grade 4. This sampling method was used to keep the groups closely balanced. To our knowledge this is the first prospective randomized study comparing the SL-MLP with the standard PP PNL techniques using Guy's score for stratified randomization.

In total, the primary stone clearance was achieved in 75.3% of patients. The mean operating time was 83.41 minutes. The average time taken to establish the tract and mean fluoroscopy time were 7.02 and 3.58 minutes, respectively. Intra-operative blood transfusion was required in 15.3% of patients. There was one case of hydrothorax, and one case of bowel perforation and death. When comparing the two position techniques, our results showed that SL-MLP PNL has less operative time, and high fluoroscopy and track formation time. However, no significant differences were observed between both group regarding the stone free rate, hospitalization time, need for auxiliary procedures and morbidity.

The goal of PNL is to obtain a stone-free status with minimal morbidity and optimal cost effectiveness. Therefore, when evaluating the results of the surgery, it is necessary to assess several outcomes, which until now have been mainly stone free status, operative time, morbidity, costs, and quality of life. However, there is a substantial variability in the reporting of such outcomes among the different studies.

In order to establish advantages and inconvenience of different positions and to decide which method is more efficient and possibly safer, comparative studies, with similar stone complexity are necessary. Unfortunately, most of results currently reported by different centers are far from being standardized **[13].** Based on the limited existing data in the literature, certain recommendations can be made to identify patient populations who are most apt to benefit from one position over the other.

The PP is recommended in patients with staghorn calculi and should be considered in those patients who possibly need upper pole access based on preoperative imaging **[25].**

The supine approach should be used in patients with heart failure who are not likely to tolerate the hemodynamic effects of anesthesia in the PP. Similarly, morbidly obese patients who cannot lie prone without pulmonary compromise should also be operated in the supine position. Either approach is acceptable in patients without complex renal calculi who do not have any significant cardiopulmonary comorbidity **[25].**

Several randomized studies were performed to compare standard prone PNL with supine position technique. In a meta-analysis of PNL positioning by **Gofrit *et al.*** **[18],** where the supine position was found to have a mean reduction of 25 minutes when compared with the PP. In a study of **Papatsoris *et al.*** **[9],** modified supine PNL significantly lower the operative time by 30 minutes, when compared with the standard prone PNL. However, the evidence for shorter operating time is not entirely in favor of the modified supine position, with a prospective randomized study by **Miano *et al.*** **[27]** reporting lower operation times in their prone group, as compared to modified supine.

The other alternative for PNL in PP is flank position. Although flank position is familiar to urologists, change to open surgery is easier in this position, and ultrasonography can be performed easily with better vision, more renal movement is its limit. **Gofrit *et al.*** **[18]** recommended the use of the lateral position for PNL in morbidly obese patients and in patients with kyphosis to avoid severe hypoxemia and hypercarbia. **Kerbl *et al.*** **[17]** used PNL with the patient in the flank position to reduce pulmonary compression of the patient.

Karami *et al.* [19] reported PNL under ultrasonography guidance in 40 patients in the lateral position with an access rate of 100% and complete stone removal rate of 85%. **Patel *et al.*** [12] performed totally ultrasonography-guided PNL in the flank position in 30 patients and revealed satisfactory outcomes compared with the standard technique of PNL. The stone-free rate was 83.3% without any major complications. In another study, **Karami *et al.*** [19] compared PNL outcomes between flank and prone positions (30 patients in each group) that the complete stone clearance was 85% in the flank position with no visceral injury. They showed that PNL is a safe and convenient procedure in patients in the lateral position under ultrasonography guidance.

In the present study, the first advantage of SL-MLP over the PP is the reduction of operative time. If compared with the PP, PNL with the patient in the SL-MLP was reported to save 42.34 minutes of total operation time.

Operative time is an ill-defined outcome variable. Many studies report it as the time between the first attempt to puncture the kidney and the suturing of the nephrostomy tube. However, this type of evaluation does not consider the operative room occupation, which includes also patient positioning, endoscopic access to the bladder, and retrograde pyelography [13].

In our study the operative time was calculated from the time of anesthesia induction till the end of suturing the nephrostomy tube. The operative time was significantly lower in SL-MLP technique ($p<0.001$).

The mean track formation time and fluoroscopy time were significantly higher in SL-MLP group. The true explanation is unknown. However, familiarity with the procedure performed in the SL-MLP may affect the track formation time and subsequently the fluoroscopy time. The relative novelty and infrequent use of the SL-MLP suggest that our center is in their discovery or learning curve.

As the track formation time is significantly higher in SL-MLP group, the 42 minutes reduction in the mean operative time of SL-MLP group can be accounted for the repositioning of the patient (and consequently repeat prepping and draping, as well as staff rescrubbing and gowning), as well as the SL-MLP position facilitating dual antegrade and retrograde access. As shown in our results, the preliminary ureteric catheter insertion was successful in 96.5% of cases and double-J stent insertion was successful in all cases of SL-MLP group; and all were performed with the patients in the same position.

Regarding the stone-free status, some authors are faithful to the strict criterion of no fragments visualized on imaging, while others employ a more permissive definition tolerating small, passable, residual stone fragments. In these latter studies, the residual fragment size varies from 2 to 10 mm. Furthermore, nearly one-third of papers evaluating surgical management of urinary calculi do not define stone-free status at all. In the present study stone free status was defined as absence of stone or residual stone fragment(s) ≤3 mm in post-operative imaging.

A further difficulty arises from the different sensitivity and specificity of the methods employed for the assessment of residual fragments. These include intraoperative flexible nephroscopy. postoperative plain X-ray KUB, US and CT. The reliability of these different methods is variable; therefore, the stone-free rate can be overestimated when using a poorly sensitive method. For example, KUB has been found to overestimate stone-free status by 35%. Although unenhanced computer tomography is the gold standard because it has the best sensitivity and specificity, it is not systematically used because of its cost and high radiation exposure.

The timing at which stone-free status should be explored after PNL is also debatable. Many studies report the stone-free rate at 3 months, believing that during this period, most small fragments will pass. Others argue that in the case of PNL, all patients should undergo an immediate postoperative CT scan, before the nephrostomy is removed[13].

In the present study, abdominal X-ray KUB was performed on the first post-operative day to ensure the tubes positioning. For evaluation of stone free status, the X-ray KUB and/or US was used in all cases with low risk of residual stones (e.g. solitary stone that removed in toto). Also X-ray KUB was used in cases with large un-branched clearly radiopaque stone, even if fragmentation was needed, provided that the endoscopic vision was un-blurred. Otherwise, the non-contrast CT was used for evaluation of stone free status. The stone free status was evaluated within the first post-operative week before tubes removal. This would allow selecting patients in whom a second look PNL would be beneficial.

The nephrostogram was not performed routinely; only done in cases with percutaneous urine leakage after repeated nephrostomy clamping.

No significant difference between SL-MLP group and standard PP group regarding the stone free rate. The reported stone free rate in SL-MLP group was 72.4%. Despite our result is lower than previously reported [19]; however, it remains possible that different factors other than the difference in patient positioning may have at least partly contributed to PNL results. Furthermore, the role of a difference in the acquired experience with either approach cannot be excluded. This is our first experience with SL-MLP. Further, we performed only 30 cases of PNL in SL-MLP compared to 140 cases in the standard PP.

To eliminate these possible determinants of PNL efficacy as well as the learning curve effect, a further study on larger group of patients "sufficient for multivariate analysis" is recommended, to evaluate the PNL position as a possible independent predictor of PNL outcome.

Our study found a higher complication rate and a higher rate of blood transfusion, overall and in SL-MLP and PP groups. Despite the higher incidence of overall complications, no significant difference was observed between both groups.

While our rates of complications were higher than the acceptable range, most of complications were of low MCC grades and treated either conservatively or medically without the need for surgical intervention. Also, it should be noted that our study was conducted at a tertiary referral Hospital where PNLs were performed on more complex stones and higher risk patients.

Similar to our study, most of previous studies found no effect of patient positioning during PNL on the hospitalization time. [27] In their prospective study that conducted to compare the surgical outcomes of PNLs performed using modified supine position with those performed in the standard PP concluded that "a significant difference was observed between both groups regarding the hospitalization time and the modified supine cohort stayed on average a day shorter in hospital than the prone group". However, this may be related to the nephrostomies rather than the position; as a large proportion of the supine PNLs, in their cohort, were done with no nephrostomies or completely tubeless, while the traditional prone PNLs all had nephrostomies, which delayed discharge from hospital.

One of the main limitations in this study was that the cases were not randomized, and therefore could introduce selection bias. However, allocation of SL-MLP cases to PP cases with similar Guy's grade may have minimized some of this selection bias.

A further limitation of this study was the learning curve associated with the SL-MLP, as most surgeons were already familiar with the PP for PNL but may not have had the same practice in the SL-MLP and thus the surgeon's experience or skills and intersurgeon variability could exist and could have an effect on the results.

CONCLUSION

PNL is the treatment of choice for renal stones ≥2 cm. There is still much controversy in the literature concerning the optimal approach for PNL. Although prone PNL remains predominant on a global level, with a superior acquired experience and more training opportunities when compared to other positions, several alternative positions are increasingly being utilized owing to the anesthetic, surgical and logistical disadvantages of PP.

SL-MLP PNL has significantly lower operative time compared with conventional PP PNL. The stone free rate, need for ancillary procedures and complication rate were equal in both groups. The SL-MLP PNL is proved to be technically feasible procedure and the stone clearance and complication rates are within the accepted values with no apparent added risk when compared with the standard prone PNL. Owing to its advantages to patients, urologists and anesthesiologists, SL-MLP may expand the application options for percutaneous renal surgery.

REFERENCES

1. **Wu P, Wang L, Wang K (2011):** Supine versus prone position in percutaneous nephrolithotomy for kidney calculi: a meta-analysis. International Urology and Nephrology, 43(1):67-77.
2. **Goodwin WE, Casey WC, Woolf W *et al.* (2002):** Percutaneous trocar (Needle) nephrostomy in hydronephrosis. The Journal of Urology, 167(2):829.

3. **Fernström I and Johansson B (1976):** Percutaneous pyelolithotomy: a new extraction technique. Scandinavian Journal of Urology and Nephrology, 10(3):257-9.
4. **Valdivia JG, Valer J, Villarroya S *et al.* (1990):** Why is percutaneous nephroscopy still performed with the patient prone?. Journal of Endourology, 4(3):269-77.
5. **Ng MT, Sun WH, Cheng CW *et al.* (2004):** Supine position is safe and effective for percutaneous nephrolithotomy. Journal of Endourology, 18(5):469-74.
6. **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. European Urology, 54(1):196-203.
7. **Anderton JM (1991):** The prone position for the surgical patient: a historical review of the principles and hazards. BJA: British Journal of Anaesthesia, 67(4):452-63.
8. **Pump B, Talleruphuus U, Christensen NJ *et al.* (2002):** Effects of supine, prone, and lateral positions on cardiovascular and renal variables in humans. American Journal of Physiology-Regulatory, Integrative and Comparative Physiology, 283(1): 174-180.
9. **Papatsoris AG, Zaman F, Panah A *et al.* (2008):** Simultaneous anterograde and retrograde endourologic access:"the Barts technique". Journal of Endourology, 22(12):2665-2666.
10. **Daels F, González MS, Freire FG *et al.* (2009):** Percutaneous lithotripsy in Valdivia-Galdakao decubitus position: our experience. Journal of Endourology, 23(10):1615-20.
11. **Lezrek M, Ammani A, Bazine K *et al.* (2011):** The split-leg modified lateral position for percutaneous renal surgery and optimal retrograde access to the upper urinary tract. Urology, 78(1):217-220.
12. **Patel RM, Okhunov Z, Clayman RV *et al.* (2017):** Prone versus supine percutaneous nephrolithotomy: what is your position?. Current Urology Reports, 18(4):26.
13. **Hoznek A, Rode J, Cracco CM *et al.* (2014):** Prone Versus Supine PNL: Results and Published Series. InSupine Percutaneous Nephrolithotomy and ECIRS. Springer, Paris.
14. **Autorino R and Giannarini G (2008):** Prone or supine: is this the question?. European Urology, 54(6):1216-8.
15. **Edgcombe H, Carter K, Yarrow S (2008):** Anaesthesia in the prone position. British Journal of Anaesthesia, 100(2):165-83.
16. **Backofen JE (1985):** Hemodynamic changes with prone position during general anesthesia. Anesth Analg., 64:194.
17. **Kerbl K, Clayman RV, Chandhoke PS *et al.* (1994):** Percutaneous stone removal with the patient in a flank position. The Journal of Urology, 151(3):686-8.
18. **Gofrit ON, Shapiro A, Donchin Y, Bloom AI, Shenfeld OZ, Landau EH, Pode D (2002):** Lateral decubitus position for percutaneous nephrolithotripsy in the morbidly obese or kyphotic patient. Journal of Endourology, 16(6):383-386.
19. **Karami H, Arbab AH, Rezaei A *et al.* (2009):** Percutaneous nephrolithotomy with ultrasonography-guided renal access in the lateral decubitus flank position. Journal of Endourology, 23(1):33-36.
20. **Lehman T and Bagley DH (1988):** Reverse lithotomy: modified prone position for simultaneous nephroscopic and ureteroscopic procedures in women. Urology, 32(6):529-531.
21. **Grasso M, Nord R, Bagley DH (1993):** Prone split leg and flank roll positioning: simultaneous antegrade and retrograde access to the upper urinary tract. Journal of endourology, 7(4):307-310.
22. **Scarpa RM, Cossu FM, De Lisa A *et al.* (1997):** Severe recurrent ureteral stricture: the combined use of an anterograde and retrograde approach in the prone split-leg position without X-rays. European urology, 31:254-256.
23. **Uría JV, Gerhold JV, López JL *et al.* (1998):** Technique and complications of percutaneous nephroscopy: experience with 557 patients in the supine position. The Journal of Urology, 160(6):1975-1978.
24. **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.

25. **Duty B, Okhunov Z, Smith A *et al.* (2011):** The debate over percutaneous nephrolithotomy positioning: a comprehensive review. The Journal of Urology, 186(1):20-25.
26. **Scoffone CM, Cracco CM, Cossu M *et al.* (2008):** Endoscopic combined intrarenal surgery in Galdakao-modified supine Valdivia position: a new standard for percutaneous nephrolithotomy?. European Urology, 54(6):1393-1403.
27. **Miano R, Scoffone C, De Nunzio C *et al.* (2010):** Position: prone or supine is the issue of percutaneous nephrolithotomy. Journal of Endourology, 24(6):931-938.