

Original Article

The possibility of access to the kidneys from posterior axillary line in supine position for percutaneous nephrolithotomy

Ali Tabibi, Amir Hossein Kashi, Seyed Ali Mohammad Mirjalili, Nastaran Mahmoudnejad, Paria Kashani, Babak Salavatipour, Mohammad Hossein Soltani *

Urology and Nephrology Research Center, Shahid Labbafinejad Medical Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

Abstract

Objective: To evaluate the possibility of access to the kidneys from posterior axillary line (PAL) in supine position for percutaneous nephrolithotomy.

Materials and Methods: 102 consecutive patients who were candidated for abdominal CT scan, enrolled in this study. In cases of impossible access, the point on the posterior surface of body which permitted safe access was determined and the percent of movement toward body midline (relative to PAL) was calculated (M.PER).

Results: Percutaneous access was simulated from upper and middle calyces of the kidney in 13% and 75% of cases, respectively. Access to the lower region was possible in 90% of right and 79% of left lower calyces, respectively ($p=0.03$). In cases with impossible access from PAL, the M.PER for a safe access was 46-47% for upper region and 34-38% for middle and lower calyces of the kidney ($P = 0.0001$).

Conclusions: Access to upper calyces from PAL was limited in some cases regarding to the presence of solid organs. Presence of colon made access impossible in the lower right and left calyces in about 10% and 20% of cases, respectively. In upper region, more deviation toward midline was necessary to establish a safe access compared with middle and lower calyces.

Key Words: Percutaneous nephrolithotomy; percutaneous access, Supine position, Posterior axillary line.

***Corresponding Author:** Mohammad Hossein Soltani, Urology and Nephrology Research Center, Shahid Labbafinejad Medical Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran. Email: mhsoltani@iurc.org.ir

Please cite this article as: Tabibi A, Kashi AH, Mirjalili SAM, Mahmoudnejad N, Kashani P, Salavatipour B, Soltani MH. The possibility of access to the kidneys from posterior axillary line in supine position for percutaneous nephrolithotomy. *Novel Biomed* 2013;1(2):43-47.

Introduction

The standard position for percutaneous nephrolithotomy (PCNL) is prone; however due to some disadvantages of prone position (circulatory and ventilatory problems, change of the patient position during operation, difficulty in conversion from spinal anesthesia to general anesthesia, intubation and contraindication in patients with some vertebral column deformities), supine position has been used in

the recent years^{1,2}. The access to the kidneys in PCNL is limited by the presence of solid organs and colon within the access tract. There are some reports regarding the prevalence of total or partial retrorenal colon in supine and prone position³⁻¹². The judgment criterion in these studies was based on a coronal line drawn from posterior margin of the kidney^{8, 10, 13}; while in PCNL the access tract can be as lateral as a line drawn from posterior axillary line (PAL) to the posterior calyces. Furthermore, access to the upper calyces of the kidney is limited by the presence of solid

organs (liver and spleen). We found no relevant anatomical studies about the feasibility of percutaneous access in supine position regarding to the intervening access tract. Even though, there are some reports about the possibility of safe access from supracostal routes^{2, 14, 15, 16} but we found no articles that explain the feasibility of supracostal access relative to external body anatomical landmarks like PAL.

In this study, we aimed to assess the possibility of percutaneous access formation from PAL to the upper, middle and lower region of the right and left kidneys in supine position.

Materials and Methods

102 consecutive patients, who were candidated for abdominal computed tomography (CT) scan, were enrolled in this study. Patients with splenomegaly, hepatomegaly, renal mass, large renal cysts and large abdominal masses were excluded. A ureteral catheter was fixed to the PAL by adhesive tapes. Then patients underwent CT scan in the supine position using 1 cm slices. The patients were evaluated for the possibility of access formation by an expert radiologist using computer compact disks of digitally produced images. For determining the possibility of accessing, a supposed line was drawn from the external ureteral catheter on the CT image to the posterior calyces of the kidneys (Fig. 1).

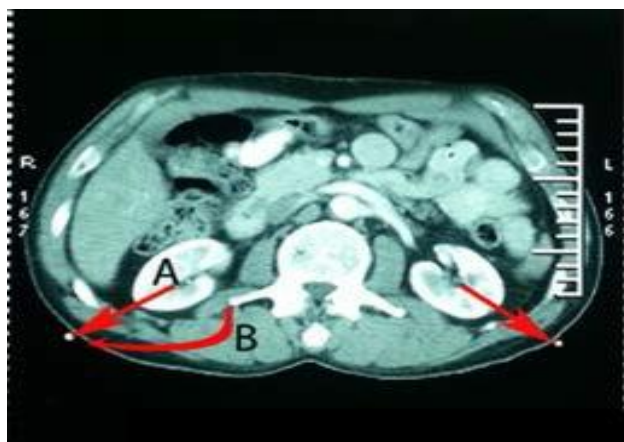


Figure 1. CT image shows simulation of the possibility of accessing to the kidney. Access was considered impossible when a solid organ or colon lied within the access tract (straight line of A), in the 1 cm vicinity of it or medial the access tract (curved line of B).

Renal access was considered impossible when a solid organ, pleural cavity or colon lied within the access tract, in the 1 cm vicinity of it or medial to the access tract. We defined the farthest point on the posterior surface of body that permitted a safe access for patients with impossible access from PAL. The percent of movement toward midline from PAL that resulted in safe access was defined the farthest point on the back that permitted a safe access. The percent of movement toward midline from PAL that resulted in safe access was defined as M.PER (Fig.2).

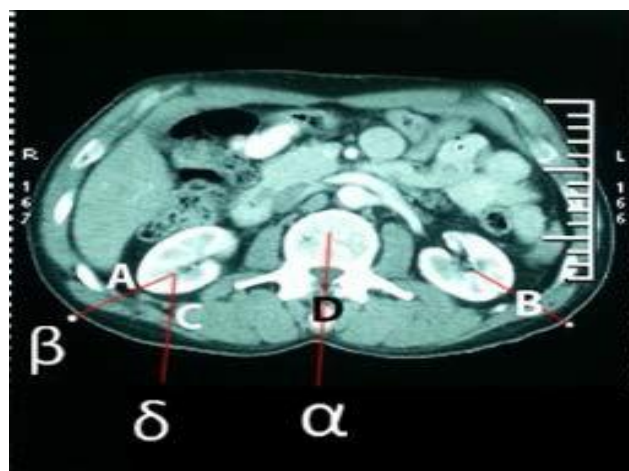


Figure 2. CT image shows simulation of access impossibility in the left and right upper pole due to the presence of edge of liver and spleen. D line has been drawn from midline. Point α is the junction of D line with patient's skin contour on the posterior body surface. Line C is the farthest line from midline that permits a safe access. Point δ is the junction of line C with patient's skin contour. M.PER is defined as $\beta\delta$ divided by α

Results

There were 47 male and 55 female with mean age of 52.6 ± 16.9 years old. Mean body mass index (BMI) of the patients was 25.1 ± 4.4 kg/m². Reasons for referral of the patients have been summarized in table 1. The relationship between access possibility and patients' age and sex have been presented in table 2.

Higher success rate in simulation of upper pole access was achieved in older patients in both sides. We found no significant association between age and access to the lower calyces of the kidney. Access from PAL to the right middle and left lower calyces was more possible in patients with higher BMI.

Table 1. Detailed information on referral reasons for CT scan.

Pain	23
Indigestion	13
GI/Hepatic cyst/mass ¹	11
Uterine abnormality	6
Kidney/bladder/prostate abnormality ²	18
Blood dyscrasia	10
Others	21

1- Masses larger than 5 cm in the longest diameter were excluded from the study

2- Kidney abnormality constituted small kidney cysts without displacement of the kidney.

Fig. 2 reveals the percent shift toward midline from PAL (defined previously as M.PER) that permits a safe access according to the definition of a safe access in this article. M.PER was nearly similar between corresponding calyces of right and left kidneys ($p = 0.741$) and M.PER was almost similar for middle and lower calyces of the kidney ($p = 0.08$). Mean M.PER was 47-48% for upper and 34-38% for middle and lower regions ($p = 0.0001$).

The possibility of accessing from PAL to the left and right kidneys in the upper, middle and lower calyces has been demonstrated in fig. 3. Percutaneous access was simulated from upper and middle calyces of the kidney in 13% and 75% of cases, respectively. Access to the lower region was successfully simulated in 90% of right lower and 79% of left lower calyces (p value = 0.03).

Table 2. Possibility of access to regions of the right and left kidney

Discussion

Our findings in this study revealed that access from PAL to the lower calyces of the kidney is more possible in the right side. There are some previous reports regarding successful supracostal access to upper region with acceptable complication rates and nearly comparable outcomes to subcostal access¹⁴⁻¹⁶.

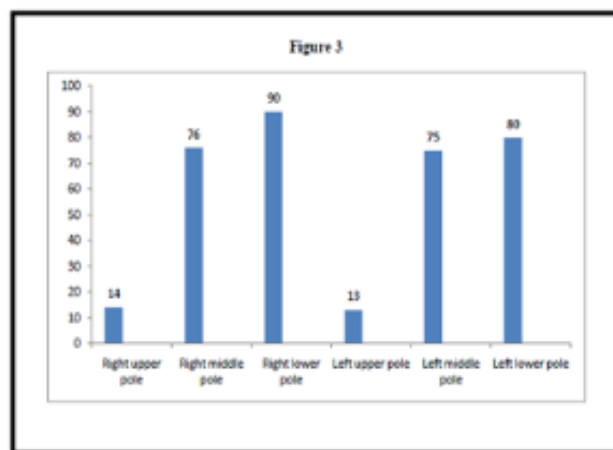


Figure 3. This Histogram shows the possibility of access formation to the left and right kidneys from posterior axillary line.

In this study, the access tract from PAL to the lateral border of the kidneys and its 1 cm vicinity was used to judge about the presence of intervening solid organs. In most of the patients with impossible access formation

Side	Region	Access possibility	Age Mean±SD	Female Sex N (%)	BMI>25 N (%)	M.PER Mean±SD
Right	Upper	Yes (N=14)	63.6±13.1	6(43)	10(71)	
		No (N=87)	50.7±16.9	48(55)	42(48)	46.3±16.9
	Middle	Yes (N=77)	51.9±16.1	40(52)	45(58)	
		No (N=24)	54.4±20.2	14(58)	7(29)	38.6±14.3
	Lower	Yes (N=91)	51.6±16.7	48(53)	49(54)	
		No (N=10)	60.9±18.5	6(60)	3(30)	34.04±13.8
Left	Upper	Yes (N=13)	67.1±13.8	5(39)	5(39)	
		No (N=89)	50.5±16.3	50(56)	47(58)	47.1±17.5
	Middle	Yes (N=76)	52.4±16.7	41(54)	42(55)	
		No (N=26)	53.0±17.8	14(54)	10(39)	38.4±13.4
	Lower	Yes (N=81)	52.5±16.4	45(56)	49(61)	
		No (N=21)	52.7±20.1	10(48)	3(14)	35.4±13.9

from PAL especially in the upper and middle regions, a slight shift of access from PAL toward midline may be led to create a safe access tract. The 75th percentile and maximum M.PERs for upper calyces were 57% and 78%, respectively. These findings imply that access establishment close to the vertebral transverse processes resulted in safe renal access in the most of cases. This observation is compatible with the previous articles that reported the feasibility of supracostal access in PCNL¹⁴⁻¹⁶ as the upper calyces of the kidneys are closer to midline relative to their lower calyces, and then usually the access puncture site would be near to midline.

There is scant data in the literature regarding to how far, if necessary surgeon can move away from midline to create a safe access. Our findings indicated that moving more than 22-23% toward PAL from midline in the upper calyces, increases the possibility of injuring a rim of liver or spleen, and moving more than 45% in upper region, raises the possibility of coming across on intervening liver or spleen surface in more than 25% of the cases. There are a few studies about the clinical importance of percutaneous tract establishment when only a rim of liver intervenes the access tract based on radiologic findings. In patients without pre operative CT scan, we think that it is advisable to request intraoperative sonography if M.PER exceeds 25% supracostal access to exclude an intervening liver or spleen.

Access from PAL to the middle region was simulated approximately 15% less than the lower calyces of the kidney. In most of these patients, the impossibility of access was due to the presence of liver or spleen margins in the right and left sides, respectively. In a few patients, the presence of retrorenal colon limited access to the middle calyces from PAL. As indicated above, in many of these instances, a more medial access route was successfully created.

The average BMI for patients with possible accessing to the different regions of the kidneys (except for the left upper pole) was higher than patient who had impossible access. These differences were statistically significant for right middle and left lower calyces. The lower BMI in patients with possible access for the left upper region may be explained by the relative few

number of patients who revealed possible access to the left upper calyces (N=5). This small number renders random error in estimating average BMI (Confidence interval 95% for BMI for patients with possible access to left upper region: 21.0-27.4). The 75th percentile and maximum M.PERs for safe access to middle and lower were in the range of 57-67% and 43-57%, respectively. In fact, more than 65% movement toward midline from PAL permitted safe access in all patients.

Lower pole access is limited by the presence of retrorenal colon. It seems that the colon may be the only organ to be at risk for injury during the simulated puncture of lower calyces of the kidney¹⁷. The presence of retrorenal colon was estimated from less than 1% to 14% in the previous reports^{4, 5, 8, 10, 11, 13, 18}. Recently, CT scan in 134 patients in prone position revealed retrorenal colon in females to be 13.4% on the right side and 26.2% on the left side¹⁹. Risk factors for retrorenal colon are slim body, female gender, lateral tract, dilated pelvicalyceal system, colon obstruction and hypermobile kidneys⁶⁻¹². Thus, preoperative CT scan in prone position should be considered to identify retrorenal colon in patients with the aforementioned risk factors and may be ultrasonography or CT guidance puncture necessary in these patients¹⁹. In the previous reports, the judgment criterion for the presence of retrorenal colon was mostly based on the presence of colon segment posterior to the kidney^{8, 10, 13}. In the current study, the tract from PAL to the posterior calyces of the kidneys, its 1 cm vicinity and the segment medial to it were introduced as a practical tool for safe entry into the kidneys in the most lateral tracts. Therefore, presence of colon lateral to the border of kidney but within the access tract was considered as a case of impossible access formation.

This study includes the following limitations:

- We accept that this study evaluated the theoretical possibility of a simulated access to the kidney from PAL in supine position and no actually renal puncture and access tract formation was performed. Thus, our findings may be not completely applicable in reality.
- In this study, we included patients who were referred for abdominal CT scan. However we

excluded patients with masses in retroperitoneum that displaced kidneys and patients with considerable hepatic or splenic enlargement or displacement; perhaps, inclusion of normal persons may modify the final results.

- Sample size was relatively small; therefore the power of statistical tests for detection of association between sex, age and BMI with access possibility was relatively low.
- According to Tuttle study¹⁷, the risk of injury may be overestimated by assessment of axial plane of CT images alone compared with oblique parasagittal plane.

The strong points of this study are:

- The attachment of ureteral catheter to the skin on PAL was a practical simulation of the place that is the lateral limit of safe percutaneous access in PCNL. This place can be different when judged on the CT scan images.
- We considered retrorenal colon as the presence of colon within the access tract from PAL to the posterior calyces of the kidney, its 1 cm vicinity or the medial segment to them. This is the exact simulation of what happens in PCNL.

Conclusion

Access to the upper pole of kidney from PAL is highly limited due to the presence of intervening solid organs in most of the patients. Lateral access to the lower region from PAL was possible in 90% of right and 79% of left kidneys, respectively. The average movement toward midline from PAL that permitted a safe access was 47% for upper region and 36% for middle or lower calyces of the kidney.

Conflict of interest

The authors have no conflict of interest.

References

1. Basiri A, Mohammadi M, Hosseini SR, Moradi Vadjargah A, Shakhssalim N, Kashi AH, et al. X-ray-free percutaneous

nephrolithotomy in supine position with ultrasound guidance. *World J Urol.* 2010 Apr; 28(2):239-44.

2. Rana AM, Bhojwani JP, Junejo NN, Das Bhagia S. Tubeless PCNL with patient in supine position: procedure for all seasons?--with comprehensive technique. *Urology.* 2008 Apr; 71(4):581-5.

3. Gerspach JM, Bellman GC, Stoller ML, Fugelso P. Conservative management of colon injury following percutaneous renal surgery. *Urology.* 1997 Jun; 49(6):831-6.

4. Hadar H, Gadoth N. Positional relations of colon and kidney determined by perirenal fat. *AJR Am J Roentgenol.* 1984 Oct; 143(4):773-6.

5. Hopper KD, Sherman JL, Williams MD, Ghaed N. The variable anteroposterior position of the retroperitoneal colon to the kidneys. The variable anteroposterior position of the retroperitoneal colon to the kidneys. *Invest Radiol.* 1987 Apr; 22(4):298-302.

6. Maillet PJ, Dulac JP, Barth X, Pelle-Francoz D, Peix JL, Bobin JY. Colonic perforations during interventional urinary radiology. *J Radiol.* 1986 Mar; 67(3):225-9.

7. Noor Buchholz NP. Colon perforation after percutaneous nephrolithotomy revisited. *Urol Int.* 2004; 72(1):88-90.

8. Prassopoulos P, Gourtsoyannis N, Cavouras D, Pantelidis N. A study of the variation of colonic positioning in the pararenal space as shown by computed tomography. *Eur J Radiol.* 1990 Jan-Feb; 10(1):44-7.

9. Rodrigues Netto N Jr, Lemos GC, Fiuza JL. Colon perforation following percutaneous nephrolithotomy. *Urology.* 1988 Sep; 32(3):223-4.

10. Sherman JL, Hopper KD, Greene AJ, Johns TT. The retrorenal colon on computed tomography: a normal variant. *J Comput Assist Tomogr.* 1985 Mar-Apr; 9(2):339-41.

11. Unal B, Kara S, Aktaş A, Bilgili Y. Anatomic variations of the colon detected on abdominal CT scans. *Tani Girisim Radyol.* 2004 Dec; 10(4):304-8.

12. Vallancien G, Capdeville R, Veillon B, Charton M, Brisset JM. Colonic perforation during percutaneous nephrolithotomy. *J Urol.* 1985 Dec; 134(6):1185-7.

13. Chan R, Li DK. An extreme case of retrorenal colon. *AJR Am J Roentgenol.* 2006 Oct; 187(4):W438.

14. Lojanapiwat B, Prasopsuk S. Upper-pole access for percutaneous nephrolithotomy: comparison of supracostal and infracostal approaches. *J Endourol.* 2006 Jul; 20(7):491-4.

15. Munver R, Delvecchio FC, Newman GE, Preminger GM. Critical analysis of supracostal access for percutaneous renal surgery. *J Urol.* 2001 Oct; 166(4):1242-6.

16. Shaban A, Kodera A, El Ghoneimy MN, Orban TZ, Mursi K, Hegazy A. Safety and efficacy of supracostal access in percutaneous renal surgery. *J Endourol.* 2008 Jan; 22(1):29-34.

17. Tuttle DN, Yeh BM, Meng MV, Breiman RS, Stoller ML, Coakley FV. 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.* 2005 Nov; 16(11):1489-92.

18. LeRoy AJ, Williams HJ Jr, Bender CE, Segura JW, Patterson DE, Benson RC. Colon perforation following percutaneous nephrostomy and renal calculus removal. *Radiology.* 1985 Apr; 155(1):83-5.

19. Chalasani V, Bissoon D, Bhuvanagir AK, Mizzi A, Dunn IB. Should PCNL patients have a CT in the prone position preoperatively? *Can J Urol.* 2010 Apr; 17(2):5082-6.