Blind Puncture in Comparison With Fluoroscopic Guidance in Percutaneous Nephrolithotomy
A Randomized Controlled Trial

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Introduction: Our aim was to evaluate blind puncture in percutaneous nephrolithotomy (PCNL) for decreasing the risk of radiation.

Materials and Methods: One hundred candidates for PCNL were randomly assigned into 2 groups. Blind access was performed for the patients in group 1 and the standard access using fluoroscopy for those in group 2. In group 1, displacement of the targeted calyx in the prone position was estimated by fluoroscopy comparing to the image on intravenous urography. Puncture of the calyx was attempted 3 cm to 4 cm below the marked site of the targeted calyx with a 30° angle. If the access to the collecting system was felt and urine came out, the site of puncture would be controlled by fluoroscopy. If the access failed, we would repeat puncturing up to 5 times.

Results: The mean time to access was 6.6 ± 2.1 minutes and 5.5 ± 1.7 minutes in groups 1 and 2, respectively ($P = .008$). The mean time of radiation exposure was 0.95 ± 0.44 minutes in group 2. A successful puncture to the targeted calyx was achieved in 50% and 90% of the patients in groups 1 and 2, respectively ($P < .001$) and a successful calculus removal in 62% and 100% of the patients in groups 1 and 2 ($P < .001$).

Conclusion: Although about half of the patients benefited from blind access in our study, this technique can not be solely relied on, and fluoroscopy or ultrasonography should be available for prevention of complications.

Keywords: percutaneous nephrolithotomy, blind puncture, fluoroscopy

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INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is the treatment of choice for kidney calculi greater than 2 centimeters in diameter and for cases of failed shock wave lithotripsy such as those with cystine calculi.[1] The routine approach for accessing the pyelocaliceal system is the placement of a ureteral catheter, injection of contrast media or air, and puncturing the caliceal system using fluoroscopy. Other methods of the caliceal access are ultrasonography-guided method using intravenous contrast injection and computed tomography-guided (CT-guided) methods, especially if there is an abnormal caliceal anatomy.[2-5]

There are few studies reporting blind access for drainage of the obstructed kidneys in emergency cases or when catheter placement for retrograde injection of a contrast medium for PCNL is not possible; the results have been acceptable and indicative of a safe technique in a hydronephrotic kidney.[6] Given the negative impact

of radiation on the patient and the surgical team during PCNL, seeking for techniques not dependent on x-ray such as ultrasonography are encouraged.[7] The blind technique can be a favorable alternative that needs to be more investigated. Our objective in the present study was to compare the efficacy of blind access to puncture the pyelocaliceal system with fluoroscopy-guided access in patients who underwent PCNL.

MATERIALS AND METHODS

In a randomized controlled trial between June 2005 and June 2006, we performed PCNL in 100 patients using either fluoroscopy-guided or blind access methods. Patients older than 15 years with a kidney or proximal ureteral calculus and without active infection, abnormal pyelocaliceal anatomy, or coagulopathy were included. They were evaluated by history taking, physical examination, blood chemistry and kidney function tests, urinalysis, and urine culture to rule out kidney dysfunction, urinary tract infection, and coagulation disorders. Intravenous urography (IVU) was performed in all patients and the size and location of the calculi, the anatomy of upper urinary system, the degree of hydronephrosis, and the targeted calyx for insertion of a Chiba needle were determined.

After providing informed consent, the eligible patients were randomly assigned into 2 groups. Using fluoroscopy, we had designed a pilot study on 20 patients and estimated the displacement of the kidney and the inferior calyx in the prone position in relation to the IVU images. The average displacement of the kidney was 1.8 cm to the cephalad direction. Accordingly, in the patients of group 1, the place of the calyx was marked on the patient's back 1.8 cm cephalad to what was seen on the IVU. Then, the access was attempted by a Chiba needle, 3 cm to 4 cm lower than the targeted calyx with a direction consistent with the infundibulopelvic angle of the respective calyx. The needle was inserted into the kidney with an angle of 30° to 40° to the patient's vertical axis of the body. If access to the collecting system was felt, the Chiba's mandarin was removed; we would be assured of the correct entrance to the caliceal system if urine came out spontaneously or by aspiration. A contrast medium or air was injected through the ureteral catheter after drainage of the urine to control the appropriateness of the position of access to the calculus by the fluoroscope. If proper access from the targeted calyx or another calyx was achieved to perform PCNL, a guide wire was inserted and the next steps were done according to the standard methods under the guidance of fluoroscopy. In case of no urine drainage, puncturing was repeated for a maximum of 5 times and if it failed, the proper access was done under fluoroscopic guidance.

Patients in group 2 underwent PCNL using fluoroscopic guidance. Under general anesthesia, a ureteral catheter was placed by cystoscopy while the patient was secured in the lithotomy position. Then, the access to the collecting system was achieved under the guidance of fluoroscopy by injection of a contrast medium with an 18-F Chiba needle in the prone position. Tract dilation and a classic PCNL were done afterwards.

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The collected data, comprising demographic characteristics, degree of hydronephrosis, time to access (from the start of puncturing to complete dilation), time of radiation exposure, number of puncturing attempts, site of access to the system, abnormal bleeding, visceral or pulmonary complications, and hemoglobin decrease were compared between the 2 groups. The student *t* test was used for normally distributed continuous variables and the chi-square test was used to compare proportional variables. Continuous variables were presented as mean ± standard deviation and a *P* value less than .05 was considered significant.

RESULTS

Fifty patients were studied in each group. All of the patients in both groups completed the study. There were no differences in the patients' demographic and clinical characteristics between groups 1 and 2 (Table 1).

A successful puncture to the targeted calyx was achieved in 25 (50%) and 45 patients (90%) in groups 1 and 2, respectively ($P < .001$). In the remaining failed cases, access was achieved to a calyx through which PCNL was possible, resulting in a successful calculus removal in a total of 31 patients (62%) in group 1 compared to that in 100% of the patients

Table 1. Demographic and Clinical Characteristics in Patients With Blind Puncture (Group 1) and Fluoroscopy-guided (Group 2) Percutaneous Nephroloithotomy*

Characteristics	Group 1	Group 2	*P*
No of patients	50	50	
Mean age, y	43.2 ± 12.3	41.6 ± 13.7	.55
Sex			
Men	34 (68)	31 (62)	
Women	16 (32)	19 (38)	.67
Involved kidney			
Left	30 (60)	28 (56)	
Right	20 (40)	22 (44)	.60
Mean body mass index, kg/m^2	25.4 ± 3.4	24.6 ± 4.0	.20
Hydronephrosis			
Mild	13 (26)	16 (32)	
Moderate	19 (38)	21 (42)	
Severe	18 (36)	13 (26)	.54

*Mean values are demonstrated as mean ± standard deviation. Values in parentheses are percents.

Tables 2. Treatment Details in Patients With Blind Puncture (Group 1) and Fluoroscopy-guided (Group 2) Percutaneous Nephrolithotomy*

Characteristics	Group 1	Group 2	*P*
Targeted calyxes			
Upper	0	1 (2)	
Middle	9 (18)	9 (18)	
Lower	41 (82)	40 (80)	.60
Successful puncture to targeted calyx	25 (50)	45 (90)	< .001
Successful calculus removal	31 (62)	50 (100)	< .001
Mean puncturing attempts	3.5 ± 2.3	3.0 ± 1.8	.19
Time to access, min	6.6 ± 2.1	5.5 ± 1.7	.008

*Mean values are demonstrated as mean ± standard deviation. Values in parentheses are percents.

in group 2 ($P < .001$). The site of inappropriate puncture was renal pelvis in 12%, out of the collecting system in 14%, and calyxes not appropriate for PCNL in 12% of the patients in group 1. Also in this group, the rate of successful access to the targeted calyx was 50% and 77.8% in the patients with mild to moderate and severe hydronephrosis, respectively.

Table 2 demonstrates the details of the treatments in each group. The mean time to access was about 1 minute longer in group 1 ($P = .008$). The mean time of radiation exposure was 0.50 ± 0.19 minutes in group 1 and 0.95 ± 0.44 minutes in group 2 ($P = .001$). Intraoperative or postoperative complications such as visceral injury and unusual bleeding did not occur in any of the patients. The mean hemoglobin decrease during the 24 postoperative hours was 1.9 ± 0.1 g/dL in group 1 and 1.7 ± 0.2 g/dL in group 2 ($P = .30$).

DISCUSSION

Percutaneous access to the pyelocaliceal system is the first measure in most percutaneous treatments such as PCNL, endopyelotomy, and the upper urinary tract drainage in obstructive uropathies. This can be achieved by insertion of a ureteral catheter for instillation of contrast medium under the guidance of fluoroscopy, ultrasonography, or CT scan.[7-9] However, a blind access may be required in cases such as obstruction or stricture of the ureter, abnormal anatomy of the ureteral orifice, or when the required equipment for the standard approach is not available. Furthermore, the known complications of radiation exposure for the surgical team in long-term have emerged lowering the duration of exposure in endourological procedures.[10]

Chien and Bellman have used blind access in 26 patients with hydronephrosis in which an urgent drainage of hydronephrosis was required and placing a ureteral catheter was not possible.[6] They had a

98% success rate, but in 14 attempts, the access to the system for introduction of the nephrostomy tube or drainage was not appropriate on ultrasonography and led to repeat puncturing. In 75% of the cases, direct access to the renal pelvis was achieved. In 1 patient, blind access failed and it was done under the guide of ultrasonography. A mean of 2.5 puncturing attempts per patient was required and no significant complication was seen. In this study, the main objective of access to the system was drainage of hydronephrosis, recovery of the obstruction, and insertion of the nephrostomy catheter. Thus, a precise selection of the targeted calyx was not required. Moreover, in this study, the degree of hydronephrosis which could affect the successful entrance into the system had not been analyzed; however, guided access to a proper calyx is a requisite in PCNLs in which direct access to the calculus is needed.

Most radiologists prefer insertion of nephrostomy tube under the guidance of ultrasonography and local anesthesia. In 2 other studies, it has been shown that percutaneous nephrostomy under the guidance of ultrasonography has a 98.5% success rate. The authors have concluded that PCNL could be done this way without the need of inserting ureteral catheter for contrast medium injection.[11,12] McDougall and colleagues have described blind access method in percutaneous approach in which the insertion of a 22-F Chiba needle with a 90° angle, 1 cm to 1.5 cm lateral to L1 vertebra, is done for antegrade procedures or contrast medium injection for the following percutaneous procedures.[13]

In our study, no complications of the initial access to the system such as abnormal bleeding, visceral injuries, and pulmonary complications were seen in neither of the groups. However, the overall rate of access to the collecting system (86%) and entrance into the targeted calyx (50%) were lower than those in the studies by Chien and Bellman (98%) and by Gupta and colleagues (98.5%).[6,11] This could be proportionally due to the lower degree of hydronephrosis in our patients and the need for a precise approach to a particular calyx in PCNL. A proper selection of the access position and the angle of introduction are crucial for preventing vascular and visceral injuries. The higher success rate in the patients with severe hydronephrosis compared to those with mild to moderate hydronephrosis (77.7% versus 50%) indicates that the blind approach can be a successful method in such patients.

The number of puncturing attempts was not different between the 2 groups of our patients, and the time of radiation exposure was 0.95 ± 0.44 minutes in group 2. Considering that a urologist is exposed to 1100 mrem of radiation every hour during PCNL and that a 5000-mrem radiation is the upper limit of the annual exposure, the excessive exposure in using fluoroscopic guidance compared to blind approach is not very higher than the upper limit and the clinical value of this radiation exposure is trivial.[10] Nonetheless, techniques with lower radiation doses are always preferred. Although blind access is successful for percutaneous nephrostomy and PCNL in severe hydronephrosis, it does not eliminate the need for imaging methods such as ultrasonography or fluoroscopy, and PCNL with safer techniques such as ultrasonography seems to be warranted for the surgical team.

CONCLUSION

Blind approach for access to the system in PCNL, especially in severely hydronephrotic kidneys, is a potential alternative for experienced surgeons for reducing radiation exposure. However, it is reasonable to guide access using fluoroscopy or ultrasonography to avoid complications related to inappropriate puncturing site and for a significant proportion of patients in whom the access will fail.

CONFLICT OF INTEREST

None declared.

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EDITORIAL COMMENT

There is no doubt that using fluoroscopy for a successful access to the kidney is essential. While learning percutaneous nephrolithotomy (PCNL), it is wise to use only fluoroscopy, and with the increasing experience of the endourologist, the time to access will be minimized. Nonetheless, concerns about radiation exposure to the surgeon and the surgical team in long-term remain. Radiation hazards can be either stochastic or nonstochastic, the former of which is not dose dependent and may cause DNA damage and lead to cancers development at any time. Thus, it is reasonable to minimize the use of the x-ray in practice. In many cases such as hydronephrotic systems and staghorn calculi, we can easily use the landmark made by intravenous urography and enter the pyelocaliceal system. According to my experience in more than 700 PCNLs by fluoroscopic guidance, I concluded that in such cases with pelvic or upper ureteral calculi, we can have access to the kidney from the lumbar notch and the success rate with blind approach is 100%, as we reported recently.[1]

I would like to express my congratulations to the authors to start blind approach and also point out some ideas: first, nonhydronephrotic systems, single calculi in the pelvis, and collecting systems with a narrow infundibulum or small pelvis are good cases for blind access, but in the present study, the authors have attempted this method regardless of these criteria. Second, to confirm the access, especially in nonhydronephrotic systems, we have to induce hydronephrosis with injection of water via the ureteral catheter simultaneously with trying access; otherwise, aspiration per se cannot be a good indicator of successful access. Third, the authors have not mentioned if the access was attempted by a single skilled surgeon or not. I believe that trying this approach without the experience of at least 300 to 400 fluoroscopy-guided PCNL can lower the success rate. And fourth, in hydronephrotic systems with large pelvis and infundibulum, the calculi can be removed by the nephroscope maneuver if the access is successful. However, in case of a narrow infundibulum, access should be achieved by the targeted calculus that necessitates the use of fluoroscopy.

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EDITORIAL COMMENT

Blind access to the pyelocaliceal system with a background of the radiographic and ultrasonographic findings is used daily in many centers around the world. It was first reported by Chien and Bellman in 2002.[1] They utilized this technique for cases in which intravenous or retrograde injection of contrast medium was not possible. They recommended to inject the contrast medium through the same needle from which urine is drained or find another location if needed (in 40% of cases).[1]

For the first time, we reported blind access to

the system and its dilation for PCNL in Persian literature, with 87% success rate in 62 cases of kidney calculus.[2] Thereafter, Karami and colleagues published their study in 2006, comparing blind access with ureteroscopy for PCNL of impacted calculi. They had only 3 failures that led to the use of fluoroscopy and changing the place of nephroscope. In the present article, Basiri and colleagues have designed an interesting randomized trial for this comparison and, as anticipated, they observed a suboptimal success rate. Accordingly, they suggested blind access only in particular selected occasions.

None of the above studies have focused on the intra-operative or postoperative surgical complications and the follow-ups were all short. It is noteworthy that removal of the calculi is not the only goal, and preservation of the kidney tissue is a crucial aim. Various instruments and techniques such as fluoroscopy, ultrasonography, computed tomography, and robots has been introduced to approach these objectives altogether.[3-5] Michel and colleagues have recently reported the complications of more than 1000 PCNLs, and by reviewing the published papers, have suggested a series of measures to reduce or prevent complications: preoperative radiologic or ultrasonographic assessment, a proper puncturing through a proper calyx, guide of an imaging modality while entering the system, atraumatic dilation by fluoroscopic monitoring, and using the minimum angle for the rigid nephroscope.[6]

Overall, along with emphasis on the safe technique for the surgical team, we should be concerned with the safety of patient and the kidney. Although blind puncture of the pyelocaliceal system with complete obstruction shows the surgeon's skill, it is suggested that antegrade contrast medium injection be done after puncturing and drainage of urine. The next steps after making sure of the needle's place would be preferred to be taken under fluoroscopic or ultrasonographic guidance.

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REPLY BY AUTHOR

We acknowledge the valuable comments by our honorable colleagues on our paper. Hereby, we would like to explain some points about our study:

1. It should be noted that in our patients, only the puncture of the pyelocaliceal system was considered, by not the access, because the safety of blind access has not been confirmed by enough evidence yet. Regarding the ethic considerations and our concern to preserve the renal parenchyma and to prevent from long-term complications, we preferred to restrict blind approach to puncturing, and if it failed after 5 attempts or the location was not appropriate, we switched to the classic approach by fluoroscopic guidance.
2. Since only blind puncture was tried and fluoroscopy was used to change the puncture site, if needed, there was no reason for long-term follow-up and assessment of late complications; we tried the classic site of entering the pyelocaliceal system regardless of the puncturing technique.
3. We designed a randomized trial, so we could not use selection criteria for the patients recruiting in the blind group; otherwise, we could not reach our aim to compare these techniques in similar groups. On the other hand, there is no documented guideline for the inclusion criteria to be used in blind access; the published studied on this issue are still limited.
4. We have used injection of solution through the

catheter, too. The suggested method of water injection and induction of hydronephrosis can be helpful only to find out whether the Chiba needle is in the pyelocaliceal system, but not to confirm its placement in an appropriate site. Our main goal was to achieve puncturing from a proper site. Likewise, contact collide of the needle to the calculus indicates reaching the calculus, but it is not predictive of an appropriate pathway for stone removal. Furthermore, it does not determine whether the needle is in a hypovascular area and far from the pelvis or the ureteropelvic junction.

5. Blind puncture was done by 2 endourology fellows who did the fluoroscopy-guided procedures, too. It should be noted that blind puncture in our study was done systematically according to the identified landmark; hence, interoperative variation does not have a significant role. Whereas, techniques that are highly dependent on the surgeon's skills and do not have a distinct method cannot be evaluated in a study and do not have external validity.

6. Even in dilated systems in which nephrostomy drainage is done, stone removal may not be possible through the same tract and access with the help of fluoroscopic or ultrasonographic guidance is required. This is indicative of blind access failure and unsuccessful stone removal with minimal complications. We should bear it in mind that entering the kidney is not the ultimate goal and a safe access should be achieved.

7. Although avoiding radiation is wise, it has been documented that the exposure of the surgical team is within the safe range, [1,2] and given the 20-year worldwide experience in PCNL, there is no reported case of malignancy among the surgeons and personnel involved with this treatment modality. The highest dose of radiation is received by the patient while PCNL. If a urologist performs 150 PCNLs per year, he/she receives a radiation dose of 2.4 mSv, while even when the contribution from other diagnostic and interventional radiologic procedures in urology is added, the total effective dose equivalent hardly exceeds 5 mSv or 10% of the allowed radiation.[3] In another study, it was shown that 50 PCNLs per year is equivalent to a maximum 2% of the allowed yearly radiation.[4]

8. Finally, to achieve a safe access to the caliceal system and the optimum avoidance of radiation, it is recommended that safer techniques with a proper visualization of the kidney anatomy while puncturing, such as ultrasonography-guided access, be used.

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