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Ultrasonographic percutaneous nephrolithotomy, with or without ureteral catheter

Telma Zahirian Moghadam¹ , Hamed Mohseni Rad^{2*} , Ali Hossein Khani² , Ahmad Ghazi³ ¹Social Determinants of Health Research Center, Ardabil University of Medical Sciences, Ardabil, Iran²Department of Surgery, School of Medicine and Allied Medical Sciences, Imam Reza Hospital, Ardabil University of Medical Sciences, Ardabil, Iran³Department of Surgery, School of Medicine and Allied Medical Sciences, Alavi Hospital, Ardabil University of Medical Sciences, Ardabil, Iran

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ABSTRACT

Introduction: Access by ultrasonography rather than fluoroscopy in addition to reducing radiation exposure to the patient and staff, is safe and effective. Access by ultrasonography is bi-planar and real-time compared to fluoroscopy, because it provides fewer side effects and more stone free rate.**Objectives:** To study the complications and outcome of PCNL (percutaneous nephrolithotomy) with or without using ureteral catheter.**Patients and Methods:** We studied 59 patients with at least 2 cm diameter of renal stone from January to December of 2018. After general anesthesia, 35 patients in the ureteral stent group were prepared in bladder lithotomy position. Then 5-French (Fr) ureteral catheters were introduced endoscopically in stone affected side and fixed to 16 Fr urethral Foley catheters in the patients. Other 24 patients in the non-stent group following anesthesia were directed to prone position instantly. In all of the patients, ultrasonography was performed in posterior auxiliary line below the ribs in prone position. Retrograde instillation of normal saline was performed through ureteral catheter in stent-group. Then we inserted 18G Chiba needle to desired calyx without needle holder guidance in all patients. Our approach according to probe was transverse.**Results:** Our patients comprised of 24 men and 35 women aged 24 to 66 years. Thirteen of them had no hydronephrosis and their stone sizes ranged from 21 mm to 65 mm. Patients in the ureteral stent group were more obese compared to the non-stent group ($P=0.02$) in addition to significantly more operation time ($P=0.03$). However hydronephrosis was not significantly different between groups ($P=0.3$). Postoperative residual stone rate, hospital stay days and complications (Fever, blood transfusion) were the same between both groups. Only urinary leak was more common in the non-stent group ($P=0.04$)**Conclusion:** Ultra-sonographic-PCNL without inserting ureteral catheter before surgery is conceivable especially in patients with lower body mass index (BMI). Advantages and complications are same in ureteral stent and non-stent patients except urinary leak that is more common in non-stent patients.

Implication for health policy/practice/research/medical education:

PCNL (percutaneous nephrolithotomy) is a minimally invasive procedure to treat renal stones larger than 2 cm. This procedure innovated 30 to 40 years ago based on X-ray scan-ning. Latter, ultrasonography became popular to access the kidney rather than X-ray. Usually at the start of surgery a ureteral catheter will be inserted endoscopically to help detect the collecting system by contrast or air or water injection retrograde. Then in prone position by a nephroscope the kidney stones will break with pneumatic or ultrasonic energy. At last a nephrostomy tube may be inserted.

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Introduction

Since the year of 1976 that percutaneous nephrolithotomy (PCNL) was invented, it has been the preferred surgical procedure to treat kidney stones with fluoroscopy guidance in more than 2 cm stone burden (1). Then, it has been revealed that access by ultrasonography rather than fluoroscopy beside reducing radiation exposure to the patient and staff, is safe and effective (2). However, in some cases such as morbid obesity sonography may not be so optimal and applicable (3). It has been shown that even with the application of tedious protective equipments, radiation exposure is not inconsequential (4). Ultrasound provides dilation path tracking and confirmation of stone removal during surgery and also allows evaluation of renal parenchyma, kidney vessels and adjacent viscera (5). In addition ultrasound education with fewer patients about 20 people is conceivable compared to fluoroscopy (6). Unfortunately, despite the common use of ultrasound in China, Europe and India, it is not common in Iran. The challenging access to calyces without hydronephrosis is troublesome with ultrasonography that may be decipherable with contrast-enhanced ultrasonography. An important advantage of sonographic access is bi-planar and real-time image with fewer side effects and more stone free rate (7,8).

Objectives

This study investigates the impact of ureteral catheter (stent) before PCNL on the complications and outcome of the procedure.

Patients and Methods

This is an analytical and cross-sectional study that compares the pros and cons of ureteral catheter insertion with no insertion in PCNL outcomes and complications. By random sampling, we recruited 59 patients with at least 2cm renal stone burden from January to December of 2018. Negative urine culture is confirmed and ceftriaxone 1 g is administered intravenously as prophylaxis. Abdomen and-pelvic spiral computed tomography (CT) had been performed for all patients.

Study design

After general anesthesia, patients were prepared in bladder lithotomy position. Endoscopically, a 5 French (Fr) ureteral catheter was introduced in affected side in 35 patients in stent-group then 16 Fr urethral catheters were fixed. Other 24 patients following anesthesia were directed to prone position instantly without ureteral catheter insertion in the non-stent group. Then ultrasonography was performed in posterior auxiliary line below the ribs in all patients.

We used 3.5 MHz range curved probe to determine kidney capsule, stones, adjacent viscera and needle advancement. Depth of the sonography is set to 8-10 cm with midrange

gain (9). The puncture site, direction and depth were examined without guide of needle holder. Retrograde instillation of normal saline was conducted in ureteral stent- group, so we inserted 18G Chiba needle without saline injection in the non-stent group and without needle holder guidance in all patients. Our approach according to probe was transverse. Afterward J-tip guide wire was inserted and incision extended to 1 cm and the tract dilated with one shot dilators. The channel was established by 30 Fr Amplatz and nephroscopy was conducted by 60-cm H₂O pressure and stones were broken by lithoclast or ultrasonic lithotripter. Finally, 14 Fr nephrostomy tube was inserted through guidewire. All patients received 3 to 4 L of normal saline per day post-operatively. Ultrasonographies were performed 7 to 20 days later.

Ethical issues

This study was extracted from Research project of Ardabil University of Medical Sciences. The Ethics Committee of Ardabil University of Medical Sciences approved this study. The institutional ethical committee at Ardabil University of Medical Sciences approved all study protocols (IR.ARUMS.REC.1399.445). Accordingly, written informed consent was taken from all participants before any intervention.

Statistical analysis

Chi-square test and t test were used to compare differences between the two groups and statistical analyses were performed using SPSS version 21. Data were expressed as mean \pm standard deviation or percentage with a significance level of $P < 0.05$.

Results

Our patients comprised of 24 men and 35 women with an age range from 24 to 66 years. Thirteen of them had no hydronephrosis and their stone sizes ranged from 21 mm to 65 mm. All surgeries were performed through single channel and subcostally. Fourteen patients received blood transfusion (3 patients 2 units and 11 patients 1 unit) because of hemorrhage and hematocrit less than 21%. The total anesthesia and operation time was 60 to 210 minutes, the hospital stay was 3 to 7 days, and the total cost was 200 to 400 USD. The patient's characteristics and stone free rates are illustrated in [Table 1](#).

As shown in [Table 1](#), patients in ureteral stent group were more obese ($P=0.02$) in addition to significantly more operation time ($P=0.03$). However hydronephrosis was not significantly different between groups ($P=0.3$). Postoperative residual stone rate, hospital stay days and complications (fever, blood transfusion) were same between the ureteral stent group and the non-stent group. Only urinary leak was more common in the non-stent group ($P=0.04$) ([Table 2](#)).

Table 1. Demographic and clinical characteristics of patients

| | With ureteral stent (n=35) | Without ureteral stent (n=24) | P value |
|-----------------------------------|----------------------------|-------------------------------|---------|
| Mean age (y) | 48.23 | 42.50 | 0.08 |
| Male (%) | 15 (25.4%) | 9 (15.3%) | 0.04 |
| Female (%) | 20 (33.9%) | 15 (25.4%) | |
| BMI (kg/m ²) | 30.94 | 28.54 | 0.02 |
| Operation & anesthesia time (min) | 155.29 | 148.75 | 0.03 |
| Stone location | | | |
| Right side (%) | 12 (20.3%) | 15 (25.4%) | 0.03 |
| Left side (%) | 23 (39.0%) | 9 (15.3%) | |
| Hydronephrosis | 26 (44.1%) | 20 (33.9) | 0.03 |

BMI, Body mass index.

Table 2. Patients' intraoperative and postoperative data

| | With ureteral stent (n=35) | Without ureteral stent (n=24) | P value |
|---------------------------|----------------------------|-------------------------------|---------|
| Complications | | | |
| Residual stone (mm) | 4.60 | 5.79 | 0.36 |
| Mean hospital stay (days) | 4.97 | 4.50 | 0.13 |
| Blood transfusion | 9 (15.3%) | 3 (5.1%) | 0.2 |
| Postoperative fever (%) | 4 (6.8%) | 3 (5.1%) | 0.6 |
| Urinary leak | 2 (3.4%) | 6 (10.2%) | 0.04 |

Discussion

Although it has been reported that retrograde saline injection or diuretics infusion may dilate calyces, (5,10) we could not determine its any helpful advantage. Ultra-sonography probe could guide in transverse or longitudinal plane. We used transverse approach because of more dynamic potential and closer and straighter tract to desired calyces (9).

The use of ultrasonography in PCNL reduces the risk of abdominal viscus injury and has a less learning curve (11). In PCNL the use of just ultrasonography or at least ultrasonography plus fluoroscopy can decrease the radiation exposure especially in children that are more vulnerable (12). PCNL with ultrasonography can be performed even in local anesthesia (13).

However, ultrasonographic access of kidney is less successful in the absence of hydronephrosis, and also formidable especially in access to the upper pole of the high lying kidneys (8).

The success rate in the access to the desired calyces is 88-99%, however the rate of complications is 8 to 9% (14). It has been reported that ultrasonography is useful in cases where ureteral catheterization or stenting is not possible to do fluoroscopic PCNL moreover sonogram could be performed in pregnant women, children and even more reliable in supine positions (9,11,15). Nevertheless, when guide wire is not visible in the urinary system by sonography, it would be so difficult to accomplish the surgery (16).

Iordache et al reported that ultrasonographic PCNL may reduce bleeding and transfusion rate especially with

Doppler mode in addition to higher stone free rate with lower cost (17). PCNL with sonography has been studied even in stag horn stones with one or two tracts(18) accompanied by ultrasonic lithotripsy.

The notable point is that we did not use needle guide on the ultrasound probe because of equipment shortage in our underprivileged region. Doppler ultrasonography appliance in access process significantly reduces the amount of bleeding and blood transfusions rate by minding great vessels (19).

The average time of calyx accessing in studies was 2 minutes. This time was about 3-15 minutes in this study. The reason could be related to loss of needle holder. The position of our patients has been prone for most of the patients as a standard position (16) except one patient that was accomplished in supine position.

It has been shown that the duration of the surgery is longer, access more challenging and the stone free rate is less successful in PCNL with the ultrasonography on the patients with BMI higher than 30 (kg/m²) as our research (20).

The ureteral catheter was inserted in 35 patients in our study that did not have many significant differences in terms of outcome or complication compared to the catheter-free group. As our study shows, PCNL with ultrasonography reduces the cost and time of surgery compared to fluoroscopy even in non-dilated calyces with stag horn stones (6).

We perform surgeries under general anesthesia in this study however; PCNL with spinal anesthesia is reported. Although tubeless PCNL was reported with no

nephrostomy insertion at the end of procedure (16), in this study we put nephrostomy in most of patients and fulfilled tubeless PCNL in some straight forward cases without major complications. Our study landmark compared to other similar researches is ultrasonography guidance that we used instead of x-ray.

As we know, similar study in ultrasonographic PCNL is lacking in the literature that compares the effectiveness of ureteral stenting in the start of the operation. We have shown that the lack of ureteral stenting at the beginning of operation reduces the time of surgery without increasing complications and stone residues.

Conclusion

Ultrasonographic-PCNL without inserting ureteral catheter at the start of surgery is conceivable especially in patients with lower BMI. Advantages and complications are same in ureteral stented and non-stented patients except urinary leak that is more common in ureteral non-stent patients.

Limitations of the study

Our most important limitation was technician callowness because the PCNL procedure has been started in our hospital freshly in adding to equipment shortages because of financial sanctions.

Authors' contribution

MRH was the principal investigators of the study. ZMT and HkA were included in preparing the concept and design. All authors participated in preparing the final draft of the manuscript, revised the manuscript and critically evaluated the intellectual contents. All authors have read and approved the content of the manuscript and confirmed the accuracy or integrity of any part of the work.

Conflicts of interest

The authors declare that they have no competing interests.

Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

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