Original Article

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Comparison of the Outcome of Combined Ultrasonic and Fluoroscopic Versus Fluoroscopic Guidance Percutaneous Nephrolithotomy

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ABSTRACT

Background: Renal stone is one of the most common renal diseases worldwide. There are several modalities for treatment of renal stone disease, one of these modalities is the use of percutaneous nephrolithatomy (PCNL) surgery which can be done either under fluoroscopic or ultrasonic or even combined fluoroscopic and ultrasonic gaudiness. The purpose of this study is to compare the outcome of combined ultrasonic and fluoroscopic versus fluoroscopic guided PCNL.

Materials and Method: This is a prospective study done in AL Basrah teaching hospital from May 2015 to December 2019, 200 patients with the diagnosis of renal stone indicated for PCNL surgery and operated on in standard prone position. One hundred forty-eight patients were operated on using fluoroscopic guidance. The other 52 patients were operated on using combined ultrasonic and fluoroscopic guided PCNL. Statistical analysis for the results regarding the outcome and complication was done using SPSS 22 program.

Results: The mean BMI of the two groups was 28 in fluoroscopic group and 27.3 in the combined ultrasonic and fluoroscopic group (p=0.30). The mean stone burden was 21.5 and 24.4 in fluoroscopic and combined group, respectively (p=0.20). The stone free rate was 85.5% in fluoroscopic group and 88.5% in combined group, that was of no significance (p = 0.16). Overall 17 patients (11.4%) in fluoroscopic group and 5 patients (9.6%) of combined group had complications (p=0.11). Mean operative time in fluoroscopic group was 85 minutes, and in the combined group it was 78 minutes (p=0.39). Mean hospital stay was two days for both groups. There were no reported cases of visceral injury in both groups.

Conclusions: This study showed that patients treated by combined ultrasonic and fluoroscopic guided PCNL had the same outcomes of fluoroscopically guided PCNL with the advantage of lower time of radiation exposure in the combined group.

Keywords: Percutaneous Nephrolithotomy, Extracorporeal Shockwave Lithotripsy, Medical Expulsive Therapy,

Abbreviations: PCS: Pelvi Calyceal System, US: Ultra Sound, CT: Computed Tomography, BMI: Body Mass Index, URS : Uretroscopy.

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INTRODUCTION

Upper urinary tract calculi affect up to 9% of population in the world.[1] Treatment modalities for renal calculi currently revolve around stone size and location and any other factor that may affect the treatment modality. These modalities include watchful waiting, medical expulsive therapy, endourological intervention and open and laparoscopic surgeries. Percutaneous nephrolithotomy (PCNL) is the gold standard for treating large renal calculi >2 cm and any condition that make treatment of the renal stone by other modalities impossible.[2, 3] PCNL has become favored over open nephrolithotomy because of its lower morbidity regarding post-operative pain and other complication and trauma to the kidney.[4] However, in comparison with ureteroscopy (URS) or extra-corporeal shock wave lithotripsy (SWL), PCNL has to be considered the most complicated stone surgery technique so in case when these modalities are available and the stone can be treated by ESWL or URS its prefer to be treated by them rather than PCNL.[5] The routine use of PCNL in some places may be limited by the difficulty in gaining percutaneous access to the kidney and targeted calyx. Renal access can be challenging, and in some centers, it is performed by intervention radiologists,[6] however in our center it is done by the urologist himself.

Lower morbidity in PCNL than open surgery can be attributed to less invasive nature of this surgery, shorter hospital stay, and early convalescence. [7]

Although the radiation exposure during PCNL is within the safe limits for expert and urologist, the mutagenic hazard is still present with this modality. There were number of studies discussing the hazards of radiation for the surgical team during PCNL all over the world, especially PCNL performed under fluoroscopic guidance.[8,9] Therefore, employing an alternative imaging technique during PCNL would be of added advantage.

While some authors' preferred using fluoroscopy combined with ultrasound (US) guidance for renal punctures to decrease the risk of radiation, others preferred to use US guidance alone to avoid radiation hazards.[10-12] The advantages of US as a guidance modality include avoidance of radiation exposure, and contrast agent usage in addition to visualization of intervening structures between the skin and the kidney.[12,13] However, US is an operator-dependent technique that requires experienced hands and it is also technically difficult in non-dilated systems.[13] The aim of the study is to compare the outcome of combined ultrasonic and fluoroscopic guidance PCNL and fluoroscopic guidance PCNL

Patients and Methods

This prospective study involved 200 adult patients with a diagnosis of single or multiple renal stones larger than 2 cm in diameter. Fifty two patients (26 %) had radiolucent stones, while 148 (74%) patients had radiopaque stones.

They underwent PCNL between May 2015 and December 2019. Patients with congenital renal anomalies or single kidney were not included in this prospective study. Patients with moderate to severe hydronephrosis or radiolucent stones were treated with the combined fluoroscopic and ultrasonic guidance PCNL , while patients with radiopaque stones were treated with fluoroscopic guidance PCNL. Group I included patients who had combined ultrasonic and fluoroscopic guidance and

group II included fluoroscopy-guided PCNL. All patients underwent preoperative urine culture and sensitivity, abdominal US and CT scan without contrast to assess renal anatomy, size and location and number of the stone. The grade of hydronephrosis was evaluated for each patient according to ultrasonic and CT finding. Prophylactic preoperative broad spectrum antibiotics in form of ceftriaxone vial 1 gm were administered for all patients 1 hour before anesthesia. Under general or epidural anesthesia, in lithotomy position the start of surgery by insertion of a 6 French ureteral catheter under fluoroscopic guidance to the targeted kidney followed by insertion of Foley's catheter. Then in prone position , the PCNL procedure was completed either by combined ultrasonic and fluoroscopic or fluoroscopic guidance.

In patients with mild hydronephrosis, 30-50 ml saline was pushed into the kidney through the ureteral catheter to increase the dilatation of pelvicalyceal system for easier insertion of the needle and proceed with PCNL.

US and fluoroscopic -guided PCNL (combined group)

A real-time gray scale US system with 3.5 MHz transducer and with the assistance of multiple images of fluoroscopy was used for this group which includes 52 patients. The renal US land markings were the capsule, the renal cortex, renal medulla, and hydronephrosis. The puncture needle was inserted initially under ultrasound for any nearby vital structure and continuous real time imaging. The site of needle entrance and the tract were directed by US. Then, a J-Tip guide wire or termo hydrophilic of 0.038 inch was inserted into the pelvicalyceal system. The tract was dilated under US guidance and fluoroscopy by Amplatz dilators up to 30 Fr. Saline with contrast was infused through the ureteral catheter to keep the PCS distended and to assist the configuration of the calyx.

The flow of fluid through the sheath ensures good access. Next, the nephroscope was inserted to the kidney through the sheath.

Pneumatic lithotripter was used to fragment the stone. Fragments were removed by stone forceps. Finally, a nephrostomy tube (14 Fr) and DJ was placed to the kidney after checking for any bleeding or any adjacent organ injury.

Fluoroscopy-guided PCNL

This done for 148 patients, after turning the patient in prone position, diluted contrast was injected through the ureteral catheter, followed by the identification of the target calyx under fluoroscopy guidance. The access was established with an 18-gauge needle using triangulation technique or bull- eye of the needle technique under fluoroscopic guidance. Then, a J-Tip or hydrophilic guide wire of 0.038 inch was inserted into the pelvicalyceal system. The tract was dilated under fluoroscopic control. The rest of the procedure was the same as described for patients in combined group PCNL. All patients received antibiotic postoperatively with good hydration and analgesia. The tube nephrostomy was removed in the 2nd post op day while the Folly's catheter after few hours to 1 day later removed and the DJ was removed 4 week postoperatively either by using rigid or flexible cystoscopy.

All patients were assessed after two weeks, for residual stones by renal US and X-ray kidney-ureter-bladder-(KUB). Success was defined as stone free or cases with insignificant residuals of < 4 mm

Exclusion criteria

Patient with single kidney, congenital renal anomalies, fever and pyelonephritis, bleeding tendency, aspirin or plavix, unfit for the surgery, wishes open surgery rather than pcnl, history of bowel surgery, spine surgery or anomalies.

Statistical Analysis

Data were analyzed using SPSS-version 22 program. P value exact test was performed for qualitative variable analysis as appropriate. Student t- test was performed for normally distributed quantitative variables. P value < 0.05 was considered statistically significant.

RESULTS

Two hundred patients aged between 20 to 60 years were suffering from single or multiple renal stone more than 2 cm underwent PCNL. One hundred forty- eight patients underwent fluoroscopic guidance PCNL and 52 patients underwent combined ultrasonic and fluoroscopic guidance PCNL. The mean BMI to the two groups was 28 in fluoroscopic group and 27.3 in the combined ultrasonic and fluoroscopic group (p=0.30) (Table 1). The mean stone burden was 21.5 and 24.4 in fluoroscopic and combined group, respectively (p=0.20) (Table 2).The degree of hydronephrosis in both groups is shown in (Table 3).

The stone free rate was 85.5% in fluoroscopic group and 88.5% in combined group, that was not significant (p=0.16).Non-significant shorter operative time was noted in the combined group patients underwent US and fluoroscopic - guided PCNL (78 minutes) versus fluoroscopic group which was (85 minutes) so the P value was 0.39 non- significant . In addition, the mean hospital stay was also non-significant for both groups which was about two days (Table 4).

Overall 17 patients (11.4%) in fluoroscopic group and 5 patients (9.6%) in in combined group had complications (p=0.11) (Table 5).

Table 1: demographic distribution of patients' data.

Total number	Combined Group	Fluoroscopic group	P value
Sex			0. 32
Male	30	104	
Female	22	44	
Age	20-60 years	20-60 years	0.12
BMI	27.3	28	0.30
Serum Creatinine preop.	1.1	1.05	0.9563
Hb preop.	13.4	13.1	0.625
Side			
Right	27	88	
Left	25	60	
Previous ESWL	10	60	

(Table 1) showing: The demographic distribution

Table2: Degree of hydronephrosis in both groups.

Degree of hydronephrosis	Number of patients In combined group	Number of patients In fluoroscopic group
Mild hydronephrosis	27	81
Moderate hydronephrosis	16	54
Sever hydronephrosis	9	13
Total	52	148

Table 3: The difference between the two groups in pre-operative data

	Procedure	Combined	Fluoroscopic	Statistic (p value)
Stone burden		20mm -36 mm	22mm -40 mm	0.20
Previous surgery		2 3.8%	6 4%	0.0832
Total number of patients		52	148	

(Table 3) Pre-Operative data.

Table 4: Intra operative data.

	Procedure	Combined	Fluoroscopic	Statistic (p value)
Number of puncture	1 puncture	30 57.7%	86 58.1%	0.953
	2 puncture	34 65.38%	80 54.05%	
	More than 3	15 28.84%	66 44.59%	
Site of puncture	Lower calyx	41 78.8%	97 65.54%	0.08
	Middle calyx	5 9.6%	9 6.1%	
	Upper calyx	6 11.5%	42 28.37%	
Access time range		6-28 minutes	8-32 minutes	0.07
fluoroscopic time range		2-3 minutes	5-14 minutes	0.001
Intraoperative bleeding		3 5.2%	8 6%	0.1
Total number of patients		52	148	
Suprascrotal		6	42	
Stone free		88.5%	85.5%	0.16
Operative time mean		78 min.	85 min.	0.39

(Table 4) The difference between the 2 groups in number of puncture, site of puncture, access time range, fluoroscopic time range and intraoperative bleeding.

Table 5:.The difference in the complications between both groups regarding (fever, bleeding requiring blood transfusion, and anesthetic complications).

Type of complication	Total number	Combined Group	Fluoroscopic group	P value
Fever	7	1	6	0.5287
Bleeding require blood transfusion	11	3	8	0.5366
Anesthetics complications	3	1	2	0.114
Hydrothorax	1	0	1	0.2
Total	22	5	17	o.68

(Table 5) Complications in both groups.

We found 88.5 % stone free rate in combined PCNL compared to 85.5% in fluoroscopic guided PCNL group According to the modified Clavien grading system of renal injury, there was no grade VI or V complications in both group (bleeding requiring angio-embolization; nephrectomy; sepsis; or even death in both patients group).

Bleeding that needed blood transfusion occurred in only three patients (5.7%) in combined, while in the fluoroscopic group it occurs in 8 patients (5.4%). These patients were managed conservatively with bed rest, hydration, and clamping of the nephrostomy tube for24 h, and blood transfusion with strict observation.

DISCUSSION

Renal stone has a serious impact on the life style of the patients. Many modalities for treatment has been developed and one of these modalities is PCNL which is done under fluoroscopic, ultrasonic or combined guidance.[2]

X-ray exposure may have serious threat to patients and to the urologists' health.[14] Therefore, the new study and efforts should be made to limit time and amount of radiation exposure. According to Haluk Söylemez et al., about 96% of urologists in Turkey use fluoroscopy guidance PCNL, only 2.8% combined US and fluoroscopic guidance PCNL, most of the urologists do not use dosimeters to calculate the amount of radiation exposure to the body, eyeglasses or even gloves. Only 46% of urologists use the thyroid shields during fluoroscopy. Some urologists consider that the using of the protective clothes is not practical, due to the heavy weight and rigidity.[15] In general, the risk of amount of radiation exposure during fluoroscopic-guided PCNL increases with increase in patient body weight, greater stone burden, and multiple puncture access tracts.[16]

In the recent years, a number of improvements in radiation exposure have been made for high quality fluoroscopic images with the lowest possible radiation dose. New fluoroscopy devices also have features, such as last image hold, pulsed fluoroscopy and digital imaging; all these can be useful to decrease the exposure of radiation to the patient and all the theater workers. [17]

In this study, despite we take all the possible measures to reduce the time of radiation exposure to the urologists and patients they have been exposed to radiation ranging from 5 to 14 minutes during fluoroscopic-guide PCNL and from 2-3 minutes during the combined ultrasonic and fluoroscopic group. It remains unclear to what extent the radiation exposure is reduced by employing US with the fluoroscopy. Combination could help Pelvi-calyceal system puncture**,** particularly in hydronephrotic kidneys.[18]

In this study, it was shown that the hydronephrosis facilitates the access to the PCS with combined and fluoroscopic PCNL access guided procedure. Several studies reported that patients with moderate to severe hydronephrosis and dilated calices have a higher stone free rate due to partly the easier access to the PCS.[17,19]

In our study, the success rate of accessing the target calyx under combined ultrasonic and fluoroscopic guided PCNL was comparable to fluoroscope-guided PCNL (Table 4).

The access time in combined US and fluoroscopic –guided PCNL was low as compared to fluoroscopic group. This decrease in X-ray exposure is always of greater value for the patient, urologist and surgical team. Our results for cases in group-1 (the combined group) are comparable to other studies done under the combined access to the mild, moderate and severe hydronephrosis.[19] Bassiri et al. reported 94% success rate in combined PCNL as one third of their patients were reported to have mild degree of hydronephrosis.[20]

It is reported that in cases when there is no hydronephrosis, making a puncture using US only is technically challenging and it may fail or it may lead to severe intraoperative bleeding.[17] In our study we dealt with such cases by injecting normal saline through ureteric catheter to distend the renal pelvicalceal system or by using fluoroscopic guided access or combined guided access technique.

Alternatively, there is an option of the use of Color Doppler US which can demonstrate the intrarenal vessels of the kidney and adjacent vessels to avoid injury to renal and other vasculature.[14] Recently in the last few years, some authors reported the using of real-time ultrasound- guided PCNL technique by using a novel Sonix GPS needle tracking system to help success of puncture on non-dilated calyces or cases with mild hydronephrosis.[14,20]

Basiri A, Mohammadi Sichani M et al showed that the stone-free rate in PCNL with the use of ultrasonography and fluoroscopic guidance technique ranged from 66.6% up to 94.7%.[20] Other similar studies showed that the stone-free rate and total stone-free rate with combined guided percutaneous nephrolithotomy ranged from 45.7% – 69.6% and 82.6 – 96.5%, respectively.[21] In our study, the results are similar to the others studies regarding the stone- free rate which was 88.5% and 85.5%, without any significant statistical difference in groups A and B, respectively (p=0.16).

In a study done by Osman M. et al, the mean operative time was 111 (range 70-180) minutes. In their study, they emphasized that ultrasonography - guided PCNL is feasible to be done but fluoroscopy must be present in the operating room.[21] In our study, the mean operative time was similar to other studies. The mean hospital stay was 3.6 days (range 2-8 days) in one study and other studies reported 2.7 to 4.1 days.[20] In our study, hospital stay was similar to other studies without any significant difference.

Gamal WM, Hussein M, Aldahshoury M, et al. reported 4-9% with postoperative fever.[18] Other studies reported 26.3-27.6% postoperative fever and the patients responded to antibiotics.[21] In this study, the incidence fever was 1.92% in combined group and 4.05 for fluoroscopic group .All patients with fever were treated with

appropriate antipyretics and antibiotics. Septic shock was not found in our patients. In other studies, like our study, there were no severe complications such as colonic or other part of the bowl injury, pneumothorax and just one case of hydrothorax in fluoroscopic group and no other adjacent injuries occurred.[22]

In current study mean BMI was similar to the other studies without any significant statistical difference between the two groups (p-value=0.3); therefore, BMI had no effect on the results of our study. We achieved access in all patients and we believe that ultrasound-guided puncture in obese patients is more difficult but it is safe and feasible.

CONCLUSION

We concluded that the main and most important difference between combined ultrasonic and fluoroscopic gaudiness PCNL is to decrease the radiation exposure in the theater. Regarding the outcome and complications, in general, there is no statistical significant difference between these two groups.

Conflict of Interest Statement

The author(s) declared that they have no conflict of interest.

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