Annals of Surgery: International
Received: Mar 07, 2016, Accepted: May 12, 2016, Published: May 16, 2016
Ann Surg Int, Volume 2, Issue 3
http://crescopublications.org/pdf/asi/ASI-2-015.pdf
Article Number: ASI-2-015

Research Article **Open Access**

Ultrasound versus Fluoroscopy Guided Percutaneous Nephrolithotomy for Treatment of Calculi in Hydronephrotic Kidneys

Hamdy Aboutaleb, MD* and Mohammed El-Shazly, MD

Assistant Professor of Urology,Urology Department, Minoufiya University Hospital, Egypt

***Corresponding Author:** Hamdy Aboutaleb, MD, Assistant Professor of Urology, Urology Department, Minoufiya University Hospitals, Minoufiya, Egypt; Tel: (00971)(050) 5323804; Fax: (00971)(04) 2678889, E-mail: hamdyabotaleb@yahoo.com

Citation: HamdyAboutaleb, MD and Mohammed El-Shazly, MD (2016) Ultrasound versus Fluoroscopy Guided Percutaneous Nephrolithotomy for Treatment of Calculi in Hydronephrotic Kidneys. Ann SurgInt 2: 015.

Abstract

Purpose: To compare the success and complication rates of ultrasound with fluoroscopically guided Percutaneous Nephrolithotomy **(**PCNL) in hydronephrotic kidneys.

Patients and Methods: The computer archived files of patients with renal calculi who underwent PCNL between October 2007 and November 2012 were retrospectively reviewed. The study included adult patients with hydronephrotic kidneys. Based on surgeon preference, included patients were divided into 2 groups. Ultrasound (U.S) guided group comprised patients who underwent ultrasound guided PCNL and fluoroscopy-guided group that included patients who underwent fluoroscopy guided PCNL. Preoperative, operative, postoperative data and outcomes (success and complication rates) were compared

Results: The study included 91 patients (mean age 44.4±11). US-guided PCNL was used in 42 patients (35 males and 7 females, mean age 40.2±13 years), and fluoroscopy in 49 patients (39 males and 10 females, mean age 43 ±21years).Mean operative time was 105 ±7.9 minutes (US-guided) versus 130±11.6 (fluoroscopy-guided) (P = 0.0001). Successful puncture was achieved in (38 patients) 90.5% in group-1 and 46 patients 93.9% in group-2 (P=0.69). Success of renal puncture in moderate/severe hydronephrotic kidneys was 96.4% versus 100%, and in mild hydronephrosis 78.6% versus 92.1% in US and fluoroscopy groups, respectively. Postoperatively, the complication rate was 9.5% in group-1, and 8.2% in group-2. Mean hospital stay was similar in both groups (3±1.5 days). The success rates were 90.5% in group1 and 93.9% in group 2, respectively.

Conclusion: In hydronephrotic kidneys, Ultrasound-guided PCNL is comparable with fluoroscopy-guided PCNL.

Keywords: Calculi; Kidney; Percutaneous Nephrolithotomy; Ultrasonography.

Abbreviations: PNL: Percutaneous Nephrolithotomy; PCS: Pelvicalyceal System; US: Ultrasound; CT: Computerized Tomography; KUB: Kidney, Ureter, Bladder (plain X-ray of urinary tract); IVU: Intravenous Urography; DJ: Double J stent; HN: Hydronephrosis.

Introduction

Percutaneous Nephrolithotomy (PCNL) was accepted as a treatment modality for large renal stones since 1980. PCNL rapidly became a routine procedure due to technological advances in endourological instruments over the last three decades it has gradually replaced open surgery for managing large renal calculi[1 - 3]. PCNL technique was optimized as an effective technique for removing kidney stones with significant decrease in complications by 1995 [4]. Lower morbidity in PCNL than open surgery can be attributed to its less invasive nature, shorter hospital stay, and early convalescence [5]. Hence, PCNL has become the treatment of choice for patients with renal calculi > 2 cm in recent years.

Although radiation exposure during PCNL is within the safe limits for expert endourologist, the mutagenic hazard is still present. There are number of studies discussing the hazards of radiation for the surgical team during PCNL, especially PCNL performed under fluoroscopic guidance [7,8]. Therefore, employing an alternative imaging technique during PCNL would be of added advantage [6]. While some authors' preferred using fluoroscopy combined with ultrasound (US) guidance for renal punctures, others preferred to use US guidance alone to avoid radiation hazards [9-11]. Many authors discussed the guidance tools, such as fluoroscopic [2,5,6], US [11,12], color Doppler US [13, 14] and CT [15], and their efficacy. The advantages and disadvantages of each modality in terms of safety and efficacy are still controversial, and the ideal one is not yet well established.

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 [11,16]. However, US are an operator-dependent guidance that requires experienced hands and it isalso technically difficult in non-dilated systems.

In this study, we present a retrospective analysis to assess the efficacy of US-guided PCNL in comparison with fluoroscopy-guided PCNL in patients with hydronephrosis due to calcular obstruction.

Patients and Methods

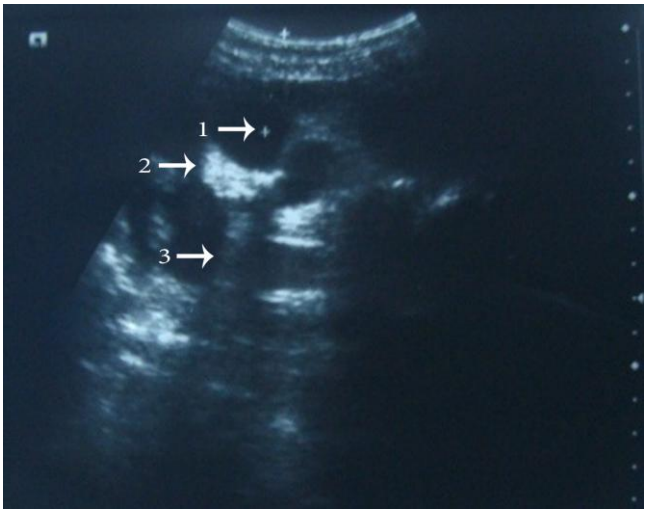
This is a retrospective study involving adult patients with a single renal stone and hydronephrosis who underwent PCNL between October 2007 and November 2012. Patients with congenital renal anomalies were not included. Based on surgeon preference, included patients were divided into 2 groups. US-guided group comprised patients who underwent ultrasound guided PCNL and fluoroscopy-guided group that included patients who underwent fluoroscopy guided PCNL.

All patients underwent abdominal US and CT scan with contrast (according to European urological association urolithiasis guidelines,2013), to clarify renal anatomy, size and location of the stone. The grade of hydronephrosis was evaluated for each patient. Following the classification by the Society for Fetal Urology, the degree of hydronephrosis was categorized as mild (grade 1), moderate (grade 2-3), and severe (grade 4)[17].

Prophylactic preoperative broad spectrum antibiotics were administered for all patients. Under general anesthesia, a 5 or 6 French ureteral catheter was inserted through a cystoscopy under fluoroscopic guidance. Then in prone position the PCNL procedure was completed. In case of mild hydronephrosis, 30-50 ml saline was infused into the kidney through the ureteral catheter to increasedilatation of pelvicalyceal system.

US-guided PCNL

A real-time gray scale US system (Acuson X300 premium edition; Siemens Medical Solutions, Seoul, Korea) with 3.5 MHz transducerwas used.The renal US landmarks were the renal capsule, renal cortex (low-level homogenous echoes), renal medulla (sonolucent structure), and hydronephrosis (hypoechoic cavity)[9].The puncture needle was inserted by US guidance. The site of needle entrance and the tract were directed by US (Figures 1a and 1b). Then, a J-Tip guide wire of 0.038 inch was inserted into the pelvicalyceal system. The tract was dilated under US guidance by elastic Teflon dilators up to 12 F and then, by telescopic metallic Alkensdilatators. Saline was continuously infused through the ureteral catheter to keep the PCS distended. The flow of fluid through the sheath ensures good access (Figure 2). Next, 30 F Amplatz sheath was inserted and the nephroscope (Karl StorzEndoskope, Tuttlingen, Germany) was used. Anultrasonic lithotripter (Calcuson, Karl StorzEndoskope, Tuttlingen, Germany) was used to fragment the stone. Fragments were removed by stone forceps. Finally, a nephrostomy tube (24 F) was placed for 48 hours.



Figures 1a and 1b: Image (a) shows the US 3.5 to 5 MHz transducer to guide the puncture of severely hydronephrotic kidney with Chiba needle in prone position under general anesthesia. Image (b) shows severe hydronephrosis due to obstructing pelvic stone with its posterior acoustic shadow and the tip of puncturing needle during US-guided PNL. (Arrow 1) shows tip of Chiba needle, (arrow 2) shows the stone, (arrow 3) shows the posterior acoustic shadow.

Figure 2: This Image shows the flow of fluid through the 30 F Amplatz sheaths that ensures good access during PNL.

Fluoroscopy-guided PCNL (Figure 3)

After ureteral catheterization, and in prone position, contrast was injected through the ureteral catheter, followed by the identification of the target calyx under fluoroscopy guidance. Access was established with an 18 gauge needle using triangulation technique under fluoroscopic guidance of a multidirectional C-arm (General Electric, Barrington, Illinois, USA). The tract was dilated under Fluoroscopic control. The rest of the procedure was the same as described for patients in US-guided PCNL.

In cases with puncture failure, re-do fluoroscopic guided PCNL were performed 1-2 weeks later.

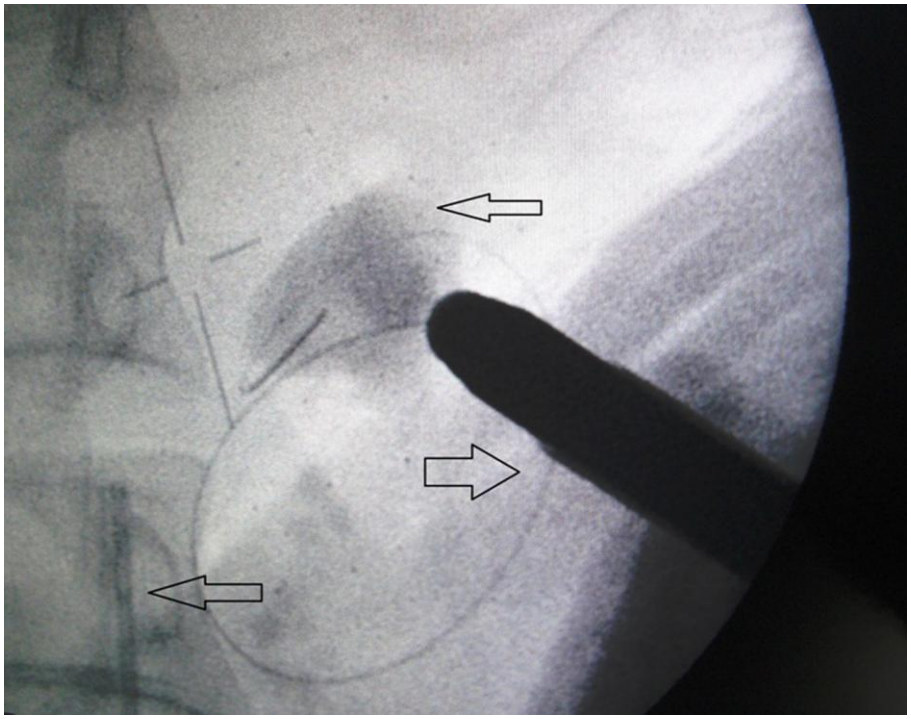


Figure 3: Fluoroscopic image during fluoroscopic guided PNL shows telescopic dilators and an obstructing stone with coiled guide wire inside hydronephrotic kidney. The ureteral catheter is seen pushed medially close to lumbar vertebrae from the hydronephrotic kidney (see arrows).

Postoperative Care

All patients were assessed on the second postoperative day and 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 < 4 mm.

Statistical Analysis

Data were analyzed using SPSS-version 21 (Statistical Package for Social Sciences Inc., Chicago, IL, USA) program. Chi square or Fischer exact test was performed for qualitative variable analysis as appropriate. Student t- test was performed for normally distributed quantitative variables and Mann-Whitney test was performedfor quantitative variables which are not normally distributed.P value < 0.05 was considered statistically significant.

Results

A total 91 patients (74 males and 17 females) aged between 24 to 60 years (mean age 44.4 ± 11 years) suffering from hydronephrosis due to calcular obstruction underwent PCNL. Mean age at surgery was 40.2±13 years (range, 20-58) for US guided PCNL and 43 ±21 (range, 18-62) for Fluoroscope guided PCNL.

Ultrasound was used for puncture in 42 patients (group-1), fluoroscope was used in 49 (group-2). The stonewas in renal pelvis in 62 patients (68%), in 25 patients, the renal pelvic stone was extended to major calyx in 25 patients (27%) and uretero-pelvic junction (UPJ) stone was in four patients (5%). Significantly shorter operative time was noted in group-1 patients underwent US-guided PCNL (group-1: 105 ± 7.9 min with a range of 50–165 min vs. group-2: 130 ± 11.6 min with a range of 45–185 min; P = 0.0001). In addition, shorter mean hospital stay was also noted in group-1, although not significant (group-1: 3 ± 1.5 days with a range of 2–4 days vs. group-2: 3.5 ± 1.6 days with a range of 2–5 days; P = 0.1).

Successful puncture was achieved in (38/42) 90.5% of patients in group-1 where 93.9% patients (946/49) in group-2. Distribution of degree of hydronephrosis and its relation to success rate is shown in (Table 1).

Table 1: Degree of hydronephrosis of both groups and the success rate

	US-guided PNL		Fluoroscopy guided PNL		Statistics
Degree of hydronephrosis	No of cases	Success of procedure	No of cases	Success of procedure %	P Value
Mild	14	11/14 (78.6%)	38	35/38 (92.1%)	N.S(0.32)
Moderate	10	9/10 (90%)	9	9/9 (100%)	N.S(1)
severe	18	18/18 (100%)	2	2/2 (100%)	N.A
Total	42	38/42 (90.5%)	49	46/49 (93.9%)	N.S(0.69)

Done by fisher exact test.

Table 2 presents the distribution of site and number of calyceal punctures (Table 2). Tables 3 and 4 show the relation between number of punctures and degree of hydronephrosisin both groups.

We found 80% stone free rate in US-guided PCNL compared to 83.7% in fluoroscopic guided PCNL group 48

Failure of puncture occurred in four patients in group-1 (three patients with mildhydronephrosis and one with moderate hydronephrosis). These four patients with unsuccessful US-guided puncture were managed by fluoroscopic guided PCNL. In group-2, we failed to establish tract in three patients, who were treated later on by Re- do fluoroscopic guided PCNL after 1-2 weeks. According to the modified Clavien grading system, there was no grade VI or V complications (bleeding requiring angio-embolisation; nephrectomy; sepsis; or death). There hours post-surgery which further improved to 90.5% and 93.9%, respectively, within two weeks follow up. This clearly indicates that all patients with successful access to the target calices were stone free within two weeks post procedure.

was no statistically significant difference between the 2 groups in Clavien grade I, II or III complications. Postoperatively, the complication rate was in 9.5% in group-1, while 8.2% in group-2. Bleeding that needed blood transfusion occurred in one patient (2.4%) in group-1, while two patients (4.1%) in group-2. These patients were managed conservatively with bed rest, hemostatic drugs, and clamping of the nephrostomy tube for 72 h. Leakage from nephrostomy site was observed in three patients (7.1%) in group-1 and two patients (4.1%) in group-2.

Table 3: Number of punctures and degree of hydronephrosis in US-guided PNLgroup.

Degree of hydronephrosis	Single puncture	2-3 punctures	> 3 punctures	Failure of puncture	P-value	Total
Mild	7 (50%)	4	-	3	(0.001)	14
Moderate/severe	27 (96.4%)	-	--	1		28
Total	34 (81%)	4	-	4		42

Table 2: Intra-operative and post-operative data.

	Procedure	Us-guided PNL group (group 1)	Fluoroscopy-guided PNL group (group 2)	Statistics (P Value)
No of punctures	Single puncture	**34**	**27**	(P=0.01)
	2-3 punctures	**4**	**14**	
	>3 punctures	**-**	**5**	
	Failed puncture	**4**	**3**	
Site of puncture	Lower calyx	**26**	35	(0.18)
	Middle calyx	**16**	12	
	Upper calyx	**-**	2	
Access time		**14.5 ± 5.6 minutes (range 6-28 min)**	**9.5** ± **1.8 (range 8- 32 min)**	(0.0001)
Stone burden		**25 ± 11.9 mm2 (21.4– 29.5 mm2)**	**28 ± 12.8 with (2.6–30 mm2)**	**0.3**
Mean fluoroscopy time		**6.7 ± 2.1 minutes (range 3-11 min)**	----	**----**
Intraoperative bleeding		**1 (2.4%)**	2 (4.2%)	(0.1)#
Previous surgery		**5 (12%)**	0	
Leakage from nephrostomy site		**3 (7.1%)**	2 (4.2%)	(0.66)#
Failure of procedure		**4 (9.5%)**	3(6.1%)	(0.69)#
Hospital stay		2-8 **(3±1.5)**	2-9 **(3.5±1.6)**	(0.13)#
Total Number of patients		**42**	**49**	

Table 4: Correlation between number of punctures and degree of hydronephrosis in fluoroscopic guided PNL.

Degree of hydronephrosis	Single puncture	2-3 punctures	>3 punctures	Failure of punctures	P Value	Total
Mild	16 (42%)	14	5	3	(0.009)	38
Moderate/severe	11 (100%)	-	--	--		11
Total	27 (55%)	14	5	3		49

Discussion

Long-term X-ray exposure may pose serious threat not only to patients but also to urologists [7]. Therefore, efforts should be made to limit such radiation exposure. According to HalukSöylemez and co-workers, while 96% of urologists in Turkey use fluoroscopy guidance as the initial choice for PCNL, only 2.8% and 1% use US guidance and CT guided access, respectively. Despite the common use of lead aprons, most urologists do not use dosimeters, eyeglasses or gloves. Only 46% of urologists always use thyroid shields during fluoroscopy. Urologists consider the usage of flexible protective clothes as not practical, because they are heavy and rigid [19]. Moreover, the risk of radiation exposure during fluoroscopic-guided PCNL increases in patients with higher body mass index, greater stone burden, branched stones, and multiple nephrostomy access tracts [2].

In recent years, a number of improvements have been made for high quality fluoroscopic images with the lowest possible radiation dose. They also have features, such as last image hold, pulsed fluoroscopy and digital imaging, for reducing patient exposure. In our series, despite taking all the measures for reducing the risk of radiation, urologists and patients were exposed to radiation for a mean value (16 ± 1.45 min) during fluoroscopic-guided PCNL. Using US for PCNL, US is typically used in conjunction with fluoroscopy [12,20]. Thus, it remains unclear to what extent the radiation exposure is used by employing US. Ultrasonography could help Pelvicalyceal system (PCS puncture)**,** particularly practical in hydronephrotic kidneys [11,18,5].

Hydronephrosis facilitates the access to the PCS with US-guided procedure. Therefore, more care should be taken in choosing patients for US-guided PCNL. Multiple studie sreported that moderate and severe hydronephrosis, few calices, and single large renal pelvic stone could increase the accessibility of stone and tract dilation [12,18]. In our study, the success of accessing the target calyx under US guided PCNL was comparable to fluoroscope-guided PCNL in moderate and severe hydronephrosis. However, in mild hydronephrotic cases, the success was less with US-guided PCNL compared to fluoroscopic guided PCNL. Despite the lower success rate of access with US-guided PCNL in the mild hydronephrosis group (78.6%) of the group-1, the X-ray free procedure with lower radiation exposure is always of greater value for the patient, urologist and surgical team. Our results for cases in group-1 are comparable to other series performing the US-guided access only to moderate to severe hydronephrosis [18]. On the other hand, Bassiri et al. reported 94% success in solo US-guided PCNL as one third of their patients were reported to have mild degree of hydronephrosis, and the results were comparable to our findings in such cases [12].

For cases with mild hydronephrotic kidneys, in group-1, success in single puncture access to PCS was 50% compared to 42.1% in group-2. While three cases (21.4%) in group-1 were reported as failure to access the PCS, four failed cases (three mild and one moderate) was noted in group-2 with fluoroscopic-guided PCNL. In group-1, we achieved success with single puncture to PCS in 96.4% (27 out of 28) with moderate and severe hydronephrosis, while 100% success was achieved in single puncture in group-2 (fluoroscopic-guided PCNL) for all the cases of moderate and severe hydronephrosis group.

In the cases where the system is not dilated, puncture using US- guided technique is technically challenging and may fail or leads to hemorrhage [18,20]. Such cases can be salvaged by doing fluoroscopic guided access as we did in our series. Alternatively, the use of Colour Doppler US can demonstrate the intrarenal vessels to avoid injury to renal vasculature. Recently, some authors reported the use of real-time ultrasound-guided PCNL using a novel SonixGPS needle tracking system to help success of puncture on non-dilated calyces or cases with mild hydronephrosis [14, 21].

The present study has some limitations, as it is retrospective and does not include large number of patients, but it is one of few studies comparing different PCNL access techniques. Further randomized controlled studies are needed to draw firm conclusions.

Conclusions

US-guided PCNL shows satisfactory outcomes in hydronephrotic kidneys with the advantage of avoidance of radiation hazards.

References

1. Wong MY. Evolving technique of percutaneous nephrolithotomy in a developing country: General Hospital experience. J Endourol 1998;12:397-401.
2. Alken P, Hutschenreiter G, Gunther R, et al. Percutaneous stone manipulation. J Urol 1981;125:463-6.
3. El-Nahas AR, Eraky I, Shokeir AA, Shoma AM, El-Assmy AM, El-Tabey NA, et al. Percutaneous nephrolithotomy for treating staghorn stones: 10 years of experience in a tertiary-care centre. Arab J Urol 2012; 10: 324–9.
4. Lingeman JE, Newmark JR, Wong MY. Classification and management of staghorncxalculi. In: Smith AD, ed. Controversies in Endourology. Philadelphia: WB Saunders, 1995, pp 136–44.
5. Perminger GM, Clayman RV, Hardeman SW, et al., Percutaneous nephrolithotomy vs open surgery for renal calculi. JAMA 1985;254:1054-8.
6. Mancini JG, Raymundo EM, Lipkin M, et al. Factors affecting patient radiation exposure during percutaneous nephrolithotomy. J Urol 2010; 184:2373-7.
7. Hellawell GO, Mutch SJ, Thevendran J, et al. Radiation exposure and the urologist: What are the risks? J Urol 2005;174:948–52.
8. Yang RM, Morgan T, Bellman GC. Radiation protection during percutaneous nephrolithotomy: A new urologic surgery radiation shield. J Endourol 2002;16:727–31.
9. Lojanapiwat B. The ideal puncture approach for PCNL: Fluoroscopy,ultrasound or endoscopy? Indian J Urol 2013;29:208-13.
10. Etemadian M, Amjadi M, Simforoosh N. Transcutaneous ultrasound guided nephrolithotomy: the first report from Iran. Urol J 2004;1:82-4.
11. Hosseini MM, Hassanpour A, Farzan R, et al. Ultrasonography-guided percutaneous nephrolithotomy. J Endourol 2009;23:603-7.
12. Basiri A, Ziaee S, Nasseh H, et al., Totally ultrasonography-guided percutaneous nephrolithotomy in the flank position. J Endourol 2008;22:1453-7
13. Karami H, Rezaei A, Mohammadhosseini M, et al. Ultrasonography-guided percutaneous nephrolithotomy in the flank position versus fluoroscopy-guided percutaneous nephrolithotomy in the prone position: a comparative study. J Endourol 2010;24:1357-61.
14. Tzeng BC, Wang CJ, Huang SW, et al. Doppler ultrasound-guided percutaneous nephrolithotomy: a prospective randomized study.Urology 2011;78:535-9.
15. Dalela D, Gupta A, Ahmed S, et al. Three-dimensional synchronized multidirectional renal pyelo-angiography: a new imaging concept to facilitate percutaneous nephrolithotomy in technically challenging cases. J Endourol 2009;23:1937-9.
16. Karami H, Arbab AH, Rezaei A, et al. Percutaneous nephrolithotomy with ultrasonography-guided renal access in the lateral decubitus flank position.J Endourol 2009;23:33-5.
17. Fernbach SK, Maizels M, Conway JJ. Ultrasound grading of hydronephrosis: Introduction to the system used by the Society for Fetal Urology. PediatrRadiol 1993;23:478-80.
18. Gamal WM, Hussein M, Aldahshoury M, et al. Solo Ultrasonography- Guided percutaneous nephrolithotomy for single stone pelvis. J Endourol 2011;25:593-6.
19. Soylemez H, Altunoluk B, Bozkurt Y, et al. Radiation exposure. Do urologists take it seriously in Turkey? J Urol 2012;187:1301-5.
20. Darabi MR, Kianian HR. The treatment of kidney stones by PCNL. Iranian Journal of Urology 1987;4:27- 37.
21. Li Xl, Long Q, Chen X, Dalin H, He H. Real-time ultrasound-guided PCNL using a novel SonixGPS needle tracking system. Urolithiasis.2014;42:341-6.