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EFFICACY OF PEROPERATIVE FLUOROSCOPY IMAGE IN DETECTION OF RESIDUAL FRAGMENTS AFTER PCNL OPERATION

PCNL OPERASYONU SONRASI REZİDÜEL FRAGMANLARIN TESPİTİNDE PEROPERATİF FLOROSKOPİ GÖRÜNTÜSÜNÜN ETKİNLİĞİ

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SUMMARY

Introduction: *To compare the combination of peroperative fluoroscopy image and the first week ultrasonography with the firsth month Non-contrast computarised tomography (NCCT) for The Detection Of Residual Fragments after Percutaneous nephrolithotomy (PCNL) operation.*

Material and Method: *A total of 208 Patients who underwent PCNL due to a radioopaque renal stone in between January 2018 to January 2019 in our clinic were included in this study. Techniques for the detection of residual fragments (RF) (fluoroscopy, plain radiography of the kidneys, ureters, and bladder (KUB), ultrasonography (US), NCCT and combination of US + fluoroscopy) were compared according to sensitivity, specificity, positive predictive value and negative predictive value*

Results: *Sensitivity and specifisity rates of the prediction of postoperative fluoroscopy and postoperative 1st week US combination were 91.3% and 98.8% (PPV: 95.5% and NPV: 97.6%) for RF status; and 91.7% and 96.5% (PPV: 84.6% and NPV: 98.2%) for CSRF (>4mm) status, respectively.*

Conclusion*: In this study, we showed that the combination of fluoroscopy and US has high sensitivity and specificity values for RF detection without x-ray exposure such as KUB and NCCT.*

ÖZ

Giriş: *Perkütan nefrolitotomi (PCNL) ameliyatı sonrası rezidüel fragmanların tespitinde peroperatif floroskopi görüntüsü ile ilk hafta ultrasonografi kombinasyonunu non kontrast bilgisayarlı tomografi (NKBT) ile karşılaştırmak.*

Gereç ve Yöntem: *Kliniğimizde Ocak 2018 - Ocak 2019 tarihleri arasında radyopak böbrek taşı nedeniyle PCNL yapılan toplam 208 hasta çalışmaya alındı. Rezidüel fragmanların (RF) tespitinde kullanılan teknikler (floroskopi, direk üriner sistem grafisi (DÜSG)), ultrasonografi (US), NKBT ve US + floroskopi kombinasyonu) duyarlılık, özgüllük, pozitif ve negatif prediktif değerler açısından karşılaştırıldı.*

Bulgular: *RF tespitinde peroperatif floroskopi görüntüsü ile ilk hafta ultrasonografi kombinasyonunun duyarlılık ve özgüllük oranları % 91.3 ve % 98.8 (PPV:% 95.5 ve NPV:% 97.6), klinik önemli rezidüel fragman tespitinde (>4mm) ise 91.7 ve% 96.5 (PPV:% 84.6 ve NPV:% 98.2) olarak bulunmuştur.*

Sonuç*: Bu çalışmada, floroskopi ve US kombinasyonunun DÜSG ve NKBT gibi x-ray maruziyeti olmadan RF tespiti için yüksek hassasiyet ve özgüllük değerlerine sahip olduğunu gösterdik.*

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is one of the minimally invasive treatment modality in the treatment of kidney stones. In the current European Association of Urology Guidelines, while PCNL application is the first choice in> 2 cm kidney stone treatment, it is an alternative to Extracorporeal Shock Wave Lithotripsy (ESWL) or retrograde intrarenal surgery (RIRS) for stones 1-2 cm and also it's recommended after ESWL and RIRS for <1cm renal Stones (1-4). The primary objective in PCNL operation is stone-free outcome, because residual stone fragments may cause pain, hematuria, urinary tract infection, urinary obstruction, will re-growth and additional interventions may be required depending on these situations (5,6). de la Rosette et al. stated that, stone free rate for PCNL is 76%, while no additional treatment was not needed for 85% of the patients during 1 month follow-up (7). This result shows the importance of the clinically insignificiant residual fragments (CIRF). The question is how should this residual stone fragments be identified after the PCNL.

Non-contrast computarised tomography (NCCT) seems to be the gold standart imaging tecnique compared to ultrasonography (US) and plain radiography of the kidneys, ureters, and bladder (KUB) for detection of residual fragments after PCNL (8,9).But, compared to US and KUB, NCCT increases detection of CIRF and the exposure to radiation.

In this study, we aimed to compare the combination of peroperative fluoroscopy image and the first week ultrasonography with the firsth month NCCT.

MATERIAL AND METHOD

A total of 208 Patients who underwent PCNL due to a radioopaque renal stone in between January 2018 to January 2019 in our clinic were included in this study. Access to the calyx was obtained under fluoroscopy by an experienced endourologist. After the dilatation of the tract with Amplatz dilatators, pneumotic lithotripter was used for stone fragmentation. Fluoroscopic guiding was used to reach stones in different calyces.

Stone free status (SFS) for fluoroscopy was defined as there was no stone on the single dose fluoroscopy at the end of the operation. If there are any residual stones, the stone size is recorded. Patients underwent KUB in postoperative 1st day, US in postoperative 1st week and NCCT in postoperative 1st month.

All CT scans were carried out using a 64 detector CT scanner (Toshiba®Aquilion64). Raw data obtained on axial plane with 1-mm slices were processed and 5-mm axial and 3-mm slices coronal and sagittal images were achieved on non-contrast CT images. Residual stones ≤4 mm were defined as CIRF and > 4 mm were defined as clinically significant residual fragments (CSRF).

Techniques for the detection of residual fragments (fluoroscopy, KUB, US, NCCT and combination of US + fluoroscopy) were compared according to sensitivity, specificity, positive predictive value and negative predictive value.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

RESULTS

A total of 208 patients who underwent postoperative fluoroscopy, postoperative 1st day KUB, postoperative 1st week US and postoperative 1st month NCCT evaluations were investigated prospectively. Patients' demographics are given in Table 1. Residual status rates after PCNL are given in Table 2 according to different imaging methods.When we evaluated SF / RF status, sensitivity rates of fluoroscopy, KUB and US were found to be 39.1%, 56.5% and 89.1%; and specificity rates were 100%, 100% ve 98.8%, respectively. Positive predictive values of fluoroscopy, KUB and US were 100%, 100% and 95.3%; negative predictive values of these were 85.3%, 89% and 97%, respectively.

In the evaluation of clinical significant / insignificant stone status, sensitivity and specificity rates were 41.6%, 66.7% and 91.7%; and 100%, 100%, 96.5% for fluoroscopy, KUB and US, respectively. Positive predictive values of fluoroscopy, KUB and US were 100%, 100% and 84.6%; negative predictive values of these were 89.1%, 93.5% and 98.2%, respectively. Prediction of RF and CSRF (>4mm) status between the imaging methods are given in Table 3. Prediction of SF and CIRF status between the imaging methods are given in Table 4.

Table 1. The demographical data of the patients

		All patients (n=208)
Age (years)		46.6±13 (18-82)
BMI (kg/m^2)		26.6±4.4 (17.3-40.4)
Sex, n (%)	Male	130 (65.5)
	Female	78 (37.5)
Stone volume (mm^3)		378.3±396.3 (39.3-2512)
Hounsfield units of the stone (HU)		1016.7±356.1 (170-1968)
Stone side, n (%)	Left	110 (52.9)
	Right	108 (47.1)
Stone location, n (%)	Pelvis, solitary	136 (65.4)
	Pelvis, multiple	19 (9.2)
	Pelvis, staghorn	27 (12.9)
	UP	5 (2.4)
	Lower pole, solitary	15 (7.2)
	Lower pole, multiple	2 (1)
	Mid+caleceal, solitary	3 (1.4)
	Upper pole	1 (0.5)
Operation time, min		106.4±37.7 (30-300)
Nephroscopy time, min		74.5±39.1 (10-230)
Fluoroscopy time, sec		52.1±41.6 (4-381)
Secondary intervention, n (%)		8 (3.8) (2PCNL, 2 RIRS, 3 URS, 1 ESWL)

Table 2. Residual status rates according to imaging methods

NCCT, n=208	SF (n=162)	RF (n=46)	CSRF (>4mm) (n=36)	CIRF (n=10)
Fluoroscopy, n	190	18	15	3
KUB, n	182	26	24	2
US, n	165	43	39	4
Combination of Fluoroscopy and US, n	164	44	39	5

Table 3. Prediction of RF and CSRF(>4mm) status between the imaging methods.

	RF and Renal units	RF on imaging methods (Sensitivities)	RF on NCCT but not in imaging methods	CSRF (>4mm) on imaging methods (Sensitivities)	CSRF (>4mm) on NCCT but not in other methods	CIRF on imaging methods	CIRF on NCCT but not in other methods
NCCT, n (%)	46 / 208	92 / 92 (100%)	0 (0%)	36 / 36 (100%)	0 (0%)	10	0 (0%)
Fluoroscopy, n (%)	18 / 208	18 / 46 (39.1%)	28 (60.9%)	15 / 36 (41.7%)	21 (58.3%)	3 (30%)	7 (70%)
KUB, n (%)	26 / 208	26 / 46 (56.5%)	20 (43.5%)	24 / 36 (66.7%)	12 (33.3%)	2 (20%)	8 (80%)
US, n (%)	41 / 208	41 / 46 (89.1%)	5 (10.9%)	33 / 36 (91.7%)	3 (8.3%)	4 (40%)	6 (60%)
Combination of Fluoroscopy and US, n (%)	44 / 208	44 / 46 (95.7%)	2 (4.3%)	33 / 36 (91.7%)	3 (8.3%)	5 (50%)	5 (50%)

Table 4. Prediction of SF and CIRF status between the imaging methods.

	SF and Renal units	SF on imaging methods (Specifities)	SF on imaging methods but not in NCCT	SF+CIRF on imaging methods (Specifities)	SF+CIRF on other methods but not in NCCT
NCCT, n (%)	162 / 208	162 / 162 (100%)	0 (0%)	172 / 172 (100%)	0 (0%)
Fluoroscopy, n (%)	190 / 208	162 / 162 (100%)	28 (17.3%)	172 / 172 (100%)	21(12.2%)
KUB, n (%)	182 / 208	162 / 162 (100%)	20 (12.3%)	172 / 172 (100%)	12 (7%)
US, n (%)	165 / 208	160 / 162 (98.8%)	5 (3.1%)	166 / 172 (96.5%)	3 (1.7%)
Combination of Fluoroscopy and US, n (%)	164 / 208	160 / 162 (98.8%)	4 (2.5%)	166 / 172 (96.5%)	3 (1.7%)

Sensitivity and specifisity rates of the prediction of postoperative fluoroscopy and postoperative 1st week US combination were 91.3% and 98.8% (PPV: 95.5% and NPV: 97.6%) for RF status; and 91.7% and 96.5% (PPV: 84.6% and NPV: 98.2%) for CSRF (>4mm) status, respectively (Table 3 and 4). Eight patients with RF positive after PCNL was undergone secondary intervention (2 pcnl, 2 rırs, 3 urs, 1 eswl). One of these patients had CIRF. In these 8 patients, RF was shown in 5 patients on only fluoroscopy, 6 patients on only KUB, 7 patients on only US and 8 (all) patients on combination of fluoroscopy and US.

DISCUSSION

Residual stone rates after PCNL are reported in a wide range in different studies (10%-60%). CIRF was considered as stone-free, in studies that reporting a high stone-free rate (10). The term CIRF was first used in the presence of non-obstructive residual fragments smaller than 4-5 mm after shock wawe lithotripsy (SWL). Later, this term was also used for residual fragments of the same characteristics after PCNL and RIRS (11). Although there is no consensus, the optimal imaging time for the detection of residual stones after PCNL is considered to be postoperative1st month (10,12,13).

KUB is the most widely used imaging method for detecting RFs after PCNL due to its advantages such as cost and low radiation exposure. However, it may be difficult to detect RF in KUB, because of the presence of intestinal gases and superposition of stents and nephrostomy tubes (14,15).

Park et al. demonstrated the superiority of CT to KUB in detecting RF. Rates for detection of stone-free status for NCCT and KUB were 62.3% and 20.8% respectively. In the same study, the sensitivity of KUB was found to be 47.6% for RF detection (10). The sensitivity of KUB in detecting RF was found to be 40.3% by Osman et al. (14). The sensitivity of KUB was 56.5% (26/46) in our study.

Residual fragments in the renal unit can be detected with US up to 2 mm. Advantages of this method include the ability to diagnose hydronephrosis, no radiation exposure and non-invasiveness (16).

US only is not recommended for the detection of RF after PCNL because its sensitivity is affected by the presence of a nephrostomy tube and postoperative changes in the collecting system (perirenal hematoma, urinoma, etc.) (14).

The sensitivity of US was found to be 57.1% in detection of RF after PCNL by Osman et al. (14). While it was found to be 89.1% in our study. However, they performed US at 48 hours postoperatively and there may be a decrease in sensitivity of US due to the presence of nephrostomy tube, perirenal hematoma and calcial dilatation. In the current study, US was performed at the end of the 1st week after the nephrostomy tube was removed.

NCCT at the 1st month after PCNL is the gold standart method for detection of RF with high sensitivity and specifity (14,10,17).

A combination of flouroscopy with intraoperative flexible nephroscopy was used for determination of stone free status by Andrew et al. The sensitivity and specifity was found to be 100% and 92% for CSRF and 30% and 92% for stone free status respectively.(18)

In current study in detection of RF, sensitivity for intraoperative flouroscopy was 39.1% but combination of flouroscopy and 1st week US had

a sensitivity of 95.7% . In the CSRF detection, while the scopy had a sensitivity of 41.7%, it increased to 91.7% when combined with 1 st week US. The sensitivity of the combination was found to be 95.7% as the stones < 4mm that could not be detected with US were seen on scopy. Residual stones that are > 4 mm could be detected by US and scopy did not provide any additional benefit so that the sensitivity of the combination was found to be 91.7%.

After PCNL, detection of residual fragments, that require secondary intervention is important for both the patient and the physician. In our study group, additional intervention was performed for 8 patients after PCNL. All residual fragments was detected by flouroscopy and US combination with no additional imaging, in these patients

There is no consensus among urologists for imaging modalities in order to determine residual fragments after PCNL. In their study, Batagello et al evaluated the imaging modalities used by urologists to detect residual fragments after PNCL and they showed that 50% of them preferred CT, 20.3% preferred KUB, 6.8% preferred US only, 21.6% combination of US and KUB (19).

This current study has some limitations. Non-opaque stones could not be seen on fluoroscopy and postoperative 7th day US depends on the experience of the radiologist.

CONCLUSION

In this study, we found that combination of fluoroscopic imaging at the end of the surgery and postoperative 7th day renal US had high sensitivity and specificity in the detection of RFs. This will result in less radiation exposure of the patient and lower cost. Further studies are needed to support the current findings.

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