Smyrna Tıp Dergisi **Araştırma Makalesi**

The Comparison of Flexible Ureterorenoscopy and Percutaneous Nephrolithotomy in 20-40 mm in Kidney Stones
Böbrek Taşlarında 20-40 mm'lik Fleksibl Üreterorenoskopi ile Perkütan Nefrolitotominin Karşılaştırılması

Deniz Ipek

MD, Department of Urology Yalova State Hospital, Yalova, Turkey

Summary

Objective: Retrograde Intrarenal Surgery and Percutaneous Nephrolithotomy are two important treatment modalitiesin 20-40 mm kidney stones. Aim of the study was to compare retrograde intrarenal surgery and percutaneous nephrolithotomy in 20-40mm kidney stones.

Materials and Method: A total of 250 patients, who admitted to outpatient clinic between May 2021 and December 2021 due to urinary system stone disease, were evaluated retrospectively. Patients, with renal stones between 20 mm–40 mm in size were included. Patients were randomized into two treatment groups: flexible ureterorenoscopy (n=120) and percutaneous nephrolithotomy (n=130).

Results: URS patients appear to have reduced operation time of 59.623 units compared to PNL patients. While the duration of scopy was higher in the URS group than in the PNL group, the values of the PNL group were higher than the URS group in all other parameters. URS patients appear to have increased fluoroscopy time of 20.927 units compared to PNL patients. URS patients appear to have a reduced hospital stay of 1.763 units compared to PNL patients. The comorbidity rate was higher in the URS group than the PNL group.

Conclusion: Although percutaneous nephrolithotomy is the gold standard in the treatment of renal stones larger than 20 mm, it should be remembered that the same success rate can be achieved with retrograde intrarenal surgical procedure with more than one session and greater than 20 mm.

Key words: Flexible ureterorenoscopy, nephrolithiasis, percutaneous nephrolithotomy, retrograde intrarenal surgery, urinary system stone diseases

Özet

Amaç: Büyüklüğü 20-40 mm olan böbrek taşlarında retrograd intrarenal cerrahi ve perkütan nefrolitotomi iki önemli tedavi modelidir. Bu çalışmanın amacı 20-40 mm böbrek taşlarında retrograd intrarenal cerrahi ve perkütan nefrolitotomi'yi karşılaştırmaktır.

Gereç ve Yöntem: Yalova Devlet Hastanesi üroloji polikliniğine Mayıs 2020 – Aralık 2021 tarihleri arasında üriner sistem taş hastalığı nedeni ile başvuran 250 hasta retrospektif olarak değerlendirildi. Çalışmaya 20 mm ile 40 mm boyutları arasında böbrek taşı olan bireyler dahil edildi. Hastalar iki tedavi grubuna randomize edildi: fleksibl ureterorenoscopy (n:120) ve perkütan nefrolitotomi (n:130).

Bulgular: URS hastaları, PNL hastalarına kıyasla 59.623 ünite daha kısa operasyon süresi geçirmiştir. URS grubunda skopi süresi PNL grubuna göre daha uzun iken, diğer tüm parametrelerde PNL grubunun değerleri URS grubuna göre daha yüksekti. URS hastalarının, PNL hastalarına kıyasla 20.927 ünite floroskopi süresine sahip olduğu görülmektedir. URS hastalarının, PNL hastalarına kıyasla hastanede kalış süresinin 1.763 birim azaldığı görülmektedir. URS grubunda komorbidite oranı PNL grubuna göre daha yüksekti.

Sonuç: Perkütan nefrolitotomi, 20 mm'den büyük böbrek taşlarının tedavisinde altın standart olmasına rağmen, birden fazla seans uygulanan retrograd intrarenal cerrahi prosedürü ile de 20 mm'den büyük taşlarda aynı başarı oranının yakalanabileceği unutulmamalıdır.

Anahtar Kelimeler: Fleksibl üreterorenoskopi, nefrolitiyasiz, perkütan nefrolitotomi, retrograd intrarenal cerrahi

Kabul Tarihi: 17.Şubat.2023

Introduction

The lifetime prevalence of urinary tract stones, on the other hand, varies between 1-15% (1). The primary goal in the treatment of kidney stones is to achieve maximum stone free operation success with minimal morbidity (2). Significant technological advances have been made in the

treatment of stone diseases in the last two decades. Previously, patients have only been treated via open surgery however, PNL and RIRC have been widely put into practice. Additionally, extracorporeal shock wave lithotripsy (ESWL) to laparoscopic stone surgeries have positioned themselves as minimally invasive methods (3,4).

Regarding the current treatment options, the purpose of treatment selection is to perform the eradication of maximum amount of stones with minimal harm to the patient (5). Therefore rapid elimination of large size stones provide lower rate of complications, shorter duration of hospital stay, faster recovery, less labor loss and increased patient comfort (5,6).

PNL is recommended as the first line alternative especially >20 mm² ESWL resistant stones, complex, buckhorn stone anomalies (7). Choosing the most appropriate treatment is associated with stone related factors (size, number, localization, composition), kidney anatomy and factors arising from the patient's clinical symptoms should be evaluated together (8,9,10). As a result of endourological developments in recent years, open surgery is performed in only 0.7-4% of urinary tract stones in advanced centers. Today, the success of treatment in kidney stones with PCNL is over 90% with repeated sessions. Although PCNL has high stone-free rates, it is a surgical method with serious life-threatening complications (10,11).

Especially in recent years, the indications of RIRC have been increasing and the frequency of its use is expanding rapidly. The reason for this is that it is the least invasive method preferred in endourology. The use of new and more powerful lasers, which has revolutionized RIRC, and the addition of new stone removal tools such as (flat wire, basket, Piranha, BIGopsy forceps, etc.) have dramatically increased stone-free rates (12).

Indications regarding the stone removal as elaborated in the European and American urology guidelines, RIRC is an important treatment alternative for stones smaller than 20 mm (13). In addition, it is stated that RIRC may be the first treatment option for stones larger than 20 mm in cases where PNL is contraindicated (14).

Retrograde Intrarenal Surgery and Percutaneous Nephrolithotomy are two important treatment modalities in 20-40 mm kidney stones. The aim of our study was to compare the effectiveness and complications of retrograde intrarenal surgery and percutaneous nephrolithotomy in 20-40mm kidney stones.

Material and Method

A total of 250 patients, who admitted to outpatient clinic between May 2021 and December 2021 due to urinary system stone disease, were evaluated retrospectively. Patients, with renal stones between 20 mm–40 mm in size were included to the study. Patients were randomized into two treatment groups: flexible ureterorenoscopy (n:120) and percutaneous nephrolithotomy (n:130). The study has been approved by the ethics committee at 01.04.2021 with protocol number 2021/33. The research has been conducted in line with the principles of Declaration of Helsinki and informed consent has been obtained from all participants.

Demographic data of the patients, size and location of stones, operation time, stone-free rates and hospital stay were analyzed. Full urinalysis, hemogram, biochemistry, direct urinary system radiography (DUSG), and non-contrast whole abdomen computerized tomography (CT) were requested from each patient before treatment. Patients were randomized into two treatment groups as flexibl URS and PCNL. A control non-contrast CT of the entire abdomen was requested in the 4th week following the operation for 226 patients included in the study.

A total of 250 primary stone patients with calculi between 20 mm and 40 mm were included and 24 (1 patient from PNL group and 23 patients from RICR group) patients were excluded from the study because they did not come to their controls.

PCNL Technique

The process has been performed with the patient in the prone position using an 18-gauge needle and under C-arm fluoroscopy. Retrograde pyelography was then performed, and percutaneous access was obtained into the desired calix using an 18-gauge needle and with the help of biplanar C-arm fluoroscopy. The percutaneous tract was dilated to 30 Fr before

placement of an Amplatz sheath in the collecting calculus were fragmented using a pnomotic lithotripter. In all cases, a 18 FR foley probe was inserted into the renal pelvis or associated calyx upon termination of the intervention. Operation times was calculated based on the time from the first attempt for access to the time the nephrostomy tube was inserted.

RIRC Technique

All stages of the procedure has been performed on the endourology table, with the patient in the lithotomy position, under C-arm fluoroscopy control. Before all procedures, the ureter on the calculus side was checked with URS to control unexpected pathologies and to facilitate access sheat placement. Any stenosis from the ureteral orifice to the ureteropelvic junction was widened with balloon dilatation. Access sheet was placed in all cases. All attempts were performed using 7.5F fiberoptic (Storz FLEX-X2, Tuttlingen, Germany) and a 200 or 273-lm laser fiber. Holmium YAG laser was used as the energy source.

At the end of laser lithotripsy fragments smaller than 2 mm were left to fall off spontaneously, fragments larger than 2 mm were taken with a basket. To confirm the success of the operation, a systematic review of the collector system was carried out at the end of the operation. A 4.8F DJ stent was routinely placed for each patient and removed 3 to 4 weeks after the procedure.

Operation time was calculated based on the time from access sheath insertion to DJ stent placement. Postoperative stone-free rates were determined based on DUSGs taken at discharge and at the 4th week postoperatively.

Statistical Analysis

Data analysis was done using SPSS for Windows 23.0 package program. Frequency and percentage were given for categorical data, and median, minimum, and maximum descriptive values for continuous data. Categorical variables were evaluated with the chi-Square test. Evaluation of the difference between groups was done with Mann Whitney U-Test. Examining the factors affecting the duration of scopy, operation time and hospital stay were evaluated with Linear Regression analysis. The results were considered statistically significant when the p value was less than 0.05.

Results

A total of 226 patients, including 129 in PNL and 97 in URS group, were included in the evaluation. There was a statistically significant relationship between the two groups in terms of comorbid disease ($p<0.05$). The comorbidity rate was higher in the URS group than the PNL group. Median stone size was greater in the PNL group than in the URS group, and the rate of residual stone formation was higher in the URS group than the PNL group ($p<0.05$) (Table 1).

The distribution of clinical features of the groups was given in Table 2. There was a statistically significant relationship and difference between the two groups in terms of operation, scopy and hospital stay, hematocrit decrease, post-operative BK and BUN ($p<0.05$). While the duration of scopy was higher in the URS group than in the PNL group, the values of the PNL group were higher than the URS group in all other parameters.

Table 3 shows the results of linear regression analysis to determine the factors affecting the duration of fluoroscopy. As a result of the evaluation, group and BMI variables were found to be statistically significant. URS patients appear to have increased fluoroscopy time of 20.927 units compared to PNL patients. An increase in body mass index by one unit causes a decrease of 0.350 units in fluoroscopy time.

Table 4 indicates the results of linear regression analysis to determine the factors affecting the operation time. As a result of the evaluation made with two models in which all variables and most convenient retrospective method were determined, group and BMI were found to be statistically significant in all variables, and hematocrit decrease variable was found to be statistically significant in the most convenient retrospective model group. In the general model, URS patients appear to have reduced operation time of 59.623 units compared to PNL patients. An increase in body mass index by one unit causes an increase of 0.300 units in the operation time. In the most convenient retrospective model, it was seen that URS patients have reduced operation time by 58.563 units compared to PNL patients. An increase in body mass index by one unit causes an increase of 5.207 units in the operation time.

Table 1. *Distribution of Participants' Demographic Characteristics by Groups*

Variables	PNL (n=129)	URS (n=97)	P-value
	Median (Min-Max) or n (%)	Median (Min-Max) or n (%)	
Age, years	45 (18-79)	47 (17-81)	0.984[a]
Gender			0.195[b]
Male	94 (72.9)	62 (63.9)	
Female	35 (27.1)	35 (36.1)	
Weight	91 (50-124)	90 (54-124)	0.484[a]
Height	175 (162-200)	173 (164-198)	0.185[a]
BMI	29.3 (15.4-41.2)	29.4 (18-41)	0.716[a]
Body Surface Area	2.1 (1.6-2.5)	2 (1.6-2.5)	0.199[a]
Comorbid Disease			**0.006[b]**
No	**82 (63.6)**	**81 (83.5)**	
Diabetes Mellitus	**15 (11.6)**	**5 (5.2)**	
Hypertension	**16 (12.4)**	**3 (3.1)**	
Hyperlipidemia	**3 (2.3)**	**4 (4.1)**	
Coronary Artery Disease	**13 (10.1)**	**4 (4.1)**	
Side			0.799[b]
Right	55 (42.6)	43 (44.3)	
Left	74 (57.4)	54 (55.7)	
Stone Localisation			**<0.0001[b]**
Kidney Upper Poles	**3 (2.3)**	**14 (14.4)**	
Kidney Medium Poles	**23 (17.8)**	**21 (21.6)**	
Kidney Renal Pelvis	**70 (54.3)**	**39 (40.2)**	
Kidney Lower Poles	**22 (17.1)**	**23 (23.7)**	
Stanhorn Stone	**11 (8.5)**	-	
Stone Size (mm2)	**750.2 (401.2-1560.4)**	**602.4 (322.8-1280.4)**	**<0.0001[a]**
Res. Stone			**0.025[b]**
No	**112 (86.8)**	**72 (74.2)**	
Yes	**17 (13.2)**	**25 (25.8)**	
Punc localisation			NA
Kidney Upper Poles	2 (1.6)	-	
Kidney Medium Poles	35 (27.1)	-	
Kidney Renal Pelvis	9 (7.0)	-	
Kidney Lower Poles	83 (64.3)	-	
Punc number	1 (1-2)	-	NA

[a] Mann Whitney U-test. [b] χ^2 test.

The results of linear regression analysis to determine the factors affecting the length of hospital stay was denoted in Table 5. As a result of the evaluation made with two models in which all variables and the most convenient retrospective method were determined, group, Postop Bk and Postop BUN were found to be statistically significant in all variables, and group, comorbid disease, Postop Bk and Postop BUN variables were found to be statistically significant in the most convenient retrospective model. In the general model, URS patients appear to have a reduced hospital stay of 1.763 units compared to PNL patients. One unit increase in the Postop Bk value causes an increase of 0.141 in the hospital stay, and an increase of one unit in the Postop BUN value causes an increase of 0.051 units. In the most convenient retrospective model, it was seen that URS patients have decreased length of hospital stay as 1.751 units compared to PNL patients. Comorbid disease causes an increase in hospital stay by 0.160 units, an increase in Postop Bk by one unit causes an increase in hospital stay by 0.142, and an increase in Postop BUN by one unit causes an increase of 0.051 units.

Discussion

Urinary system stone disease is the most common urinary pathology after urinary tract infections and prostate diseases. The size, location and number of stones, the anatomical features of the urinary system, and the patient's comorbidities should be evaluated together for planning the appropriate treatment modality. The

Table 2. *Distribution of the Clinical Characteristics of the Participants by Groups*

Variables	PNL (n=129)	URS (n=97)	P-value
	Median (Min-Max) or n (%)	Median (Min-Max) or n (%)	
Operation number			0.140[b]
Primary	103 (79.8)	82 (84.5)	
Secondary	21 (16.3)	15 (15.5)	
Tertiary	5 (3.9)	-	
Pnm. Number	764 (70-3630)	-	NA
Mai Mic	**20 (6-30)**	**6 (0-12)**	**<0.0001[a]**
Operation time (minutes)	**124 (45-280)**	**70 (30-100)**	**<0.0001[a]**
Scopy Time (minutes)	**6.2 (0.4-17.9)**	**22 (10-88)**	**<0.0001[a]**
Duration of hospital stay (days)	**4 (3-16)**	**1 (1-10)**	**<0.0001[a]**
Entry Site			NA
Subcostal	104 (81.3)	-	
Intercostal	14 (10.9)	-	
Subcostal+Intercostal	10 (7.8)	-	
Degree of hydronephrosis			NA
None	11 (8.6)	-	
Mild	20 (15.6)	-	
Moderate	69 (53.9)	-	
Severe	28 (21.9)	-	
Nephrostomy withdrawal day	3 (0-5)	-	NA
Pre-op Hg	13.6 (10.8-17.8)	13.1 (10.8-17.8)	0.134[a]
Post-op Hg	11.4 (6.5-17.3)	11.6 (7.3-17.4)	0.136[a]
Hematocrit decrease	**1.9 (0.2-7.4)**	**1.3 (0.1-6)**	**<0.0001[a]**
Pre-op WBC	8 (5.2-11.2)	8.4 (5.2-10.4)	0.329[a]
Post-op WBC	**13.9 (10.4-28.9)**	**12.6 (6.3-21.4)**	**<0.0001[a]**
Pre-op Bun	15 (6-27)	14 (7-29)	0.568[a]
Post-op Bun	**16 (7-82)**	**13 (7-92)**	**0.001[a]**
Pre-op Creatinine	0.8 (0.1-9)	0.8 (0.4-9)	0.563[a]
Post-op Creatinine	0.9 (0.4-3.4)	0.8 (0.5-2.5)	0.146[a]
Complication			**0.039[b]**
No	**91 (70.5)**	**80 (82.5)**	
Yes	**38 (29.5)**	**17 (17.6)**	

[a] Mann Whitney U-test. [b] χ^2 test.

Table 3. *Multivariate Linear Regression Analysis for factors affecting fluoroscopy time*

		B	Beta	P-value
Enter Method	Fixed	-6.355		
	Group	**20.927**	**0.730**	**<0.0001**
	Age	-0.034	-0.033	0.545
	Gender	-0.312	-0.010	0.832
	BMI (kgm^2)	**-0.350**	**-0.120**	**0.014**
	Comorbid Disease	0.292	0.025	0.660
	Hem. Düş	0.269	0.023	0.682
	Postop Bk	0.174	0.042	0.454
	Postop BUN	-0.008	-0.007	0.902
Backward Method	Fixed	-3.632		
	Group	**20.166**	**0.704**	**<0.0001**
	BMI (kgm^2)	**-0.366**	**-0.125**	**0.008**

Table 4. *Multivariate Linear Regression Analysis for factors affecting operation time*

		B	Beta	P-value
Enter Method	Fixed	174.791		
	Group	**-59.623**	**-0.582**	**<0.0001**
	Age	-0.049	-0.013	0.827
	Gender	8.338	0.076	0.157
	BMI (kgm^2)	**0.300**	**0.029**	**0.597**
	Comorbid Disease	0.290	0.007	0.913
	Hematocrit decrease	4.875	0.119	0.064
	Postop Bk	-0.142	-0.010	0.878
	Postop BUN	0.089	0.024	0.723
Backward Method	Fixed	181.521		
	Group	**-58.563**	**-0.572**	**<0.0001**
	Hematocrit decrease	**5.207**	**0.127**	**0.021**

Table 5. *Multivariate Linear Regression Analysis for factors affecting length of hospital stay*

		B	Beta	p-değeri
Enter Method	Sabit	3.019		
	Fixed	**-1.763**	**-0.433**	**<0.0001**
	Group	0.003	0.018	0.700
	Age	0.066	0.015	0.713
	Gender	-0.017	-0.040	0.331
	BMI (kgm^2)	0.156	0.094	0.054
	Comorbid Disease	0.141	0.087	0.077
	Hematocrit decrease	**0.140**	**0.240**	**<0.0001**
	Postop Bk	**0.051**	**0.338**	**<0.0001**
Backward Method	Postop BUN	2.633		
	Fixed	**-1.751**	**-0.430**	**<0.0001**
	Group	**0.160**	**0.096**	**0.023**
	Hematocrit decrease	0.145	0.089	0.067
	Fixed	**0.142**	**0.243**	**<0.0001**
	Group	**0.051**	**0.338**	**<0.0001**

aim of the treatment of urinary system stones is to achieve the highest stone-free rate with the lowest morbidity. Therefore, less invasive endourological methods are used in the treatment of urinary system stone disease today. PCNL is the treatment of choice for stones larger than 300 mm^2 as well as for complex renal stones. Although this procedure has high stone-free rates, it can lead to significant complications despite technological advances (13,14,15).

The low success rate of ESWL and the high morbidity of PCNL, especially in lower calyceal stones, led researchers to other alternatives. RIRC is a useful alternative to PCNL and ESWL in low-volume lower calyceal Stones (14). It has a lower complication rate compared to PCNL and similar stone-free rates to ESWL. Bozkurt et al. (2011) compared the stone-free rates of 42 PCNL and 37 RIRS patients with kidney stones measuring 15-20 mm (16). While the success rate of PCNL was 92.8%, the success rate of RIRC was found to be 89.2% (16). In recent studies with the developing technology, the stone-free rate of RIRC in the treatment of stones larger than 20 mm has been found to be as high as 77-93% (17,18).

Akman et al. (2011) found the stone-free rate as 73.5% after a single session of RIRS in their study. They have included patients with 20-40 mm kidney stones (19). The stone-free rate has been 91.2% after a single session of PCNL. After the second session of RIRC, stone-free rates increased to 91.2% (19). In the study, the stone-free rate was 74.2% after a single session of RIRC, while the stone-free rate was 86% after a single session of PCNL. The difference was not statistically significant leading us to perform the second and third sessions of RIRC. The stone

free rate and residual stone amount is lower in PNL compared to RIRC.

Ureteroscopic operation times of 20-40 mm kidney stones have been reported as 66 minutes by Breda et al. (17) , 74 minutes by Hyam et al. (18) and 64 minutes by Mariani et al. (20). In the study it was found to be 70 (30-100) minutes for RIRC and 124 (45-280) minutes for PCNL ($p<0.0001$). The durations in the study are significantly longer when compared to the literature.

There are studies in previous literature examining the relationship between the complications that develop in patients treated with PCNL and the duration of the operation (21). Common PCNL complications include bleeding requiring blood transfusion, septicemia, colon damage, hemothorax, fever, and urinary tract infection. Bleeding requiring blood transfusion are major complications, and its incidence varies between 0.8-45%. Akman et al. (2011) reported that the need for blood transfusion increased in PCNL patients when the operation time exceeded 58 minutes (22).

When the retrograde intrarenal surgery group was compared with the PCNL group, it was found that the length of hospital stay was longer in the PCNL group. The most important reasons for prolonged hospitalization were nephrostomy catheter placed for drainage, need for analgesia and follow-up after blood transfusion. In the study the mean hospital stay was found to be 1 (1-10) days for the RIRS group and 4 (3-16) days for the PCNL group. The hospital stay of patients who underwent RIRS was significantly shorter compared to patients who underwent PCNL ($p<0.0001$).

The main limitation of the study could be attributed to its retrospective nature. In addition, the localization of kidney stones was another variable ignored in this research. In the study, mainly, the stone-free rates, complication rates and hospitalization times in the treatment of urinary tract calculi between 20mm and 40mm in F-URS and PCNL procedures were compared.

PNL has been performed in the study institution for many years. On the contrary RIRC procedures have been implemented more recently. This might be the reason for prolonged scopy time in RIRC. Additionally, the requirement of multiple sessions and high costs in RIRC drives the physician towards PNL.

Conclusion

Both retrograde intrarenal surgery and percutaneous nephrolithotomy procedures are treatment options for renal calculi with high success rates. Retrograde intrarenal surgery and PCNL procedures are both treatment PNL and RIRC are used in the treatment of kidney stones due to their high success rates. Although PCNL is the gold standard in the treatment of kidney stones larger than 20 mm, it should be noted that the same success rate can be achieved in stones larger than 20 mm with the RIRS procedure applied in more than one session.

Funding
There is no specific funding related to this research.

Editorial Support
The editorial support of this article has been conducted by QA Executive Consultancy, Ozan Batigun MD, MBA in 2021. www.QAexeutiveconsultancy.com

Competing interests
The authors declare that they have no competing interests.

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Correspondance:
Deniz Ipek MD
Department of Urology Yalova State Hospital, Yalova, Turkey
E-mail: dr.denizipek@gmail.com
Mobile: +90.541.6513260