Original Article – Urolithiasis

Grand J Urol 2021;1(3):96-100
DOI: 10.5222/GJU.2021.53825

The Impact of Ureterenoscopic Stone Removal Timing on Kidney Functions: A Retrospective Analysis of 137 patients in a Single Center

Üreterenoskopik Taş Cerrahisi Zamanlamasının Böbrek Fonksiyonlarına Etkisi: Tek Merkezde 137 Hastanın Retrospektif Analizi

Ahmet Semih Guleser, Mert Ali Karadag

Department of Urology, University of Health Sciences, Kayseri City Education and Research Hospital, Kayseri, Turkey

Cite as: Guleser AS, Karadag MA. The Impact of Ureterenoscopic Stone Removal Timing on Kidney Functions: A Retrospective Analysis of 137 patients in a Single Center. Grand J Urol 2021;1(3):96-100.

Submission date: 17 June 2021 **Acceptance date:** 03 August 2021 **Online first:** 13 August 2021 **Publication date:** 20 September 2021

Corresponding Author: Ahmet Semih Guleser / University of Health Sciences, Kayseri City Education and Research Hospital, Department of Urology, Kayseri, Turkey / aseguleser@gmail.com ORCID ID: 0000-0001-6058-3744

Abstract

Objective: To investigate the effect of ureterorenoscopic stone removal timing on kidney function in unilateral ureteral stones.
Materials and Methods: Hundred and eighty-seven patients included in the study were divided into two groups: 98 patients who underwent surgery ≤14 days after the stone diagnosis constituted the Early Surgery Group and 39 patients who were operated >14 days after the stone diagnosis comprised the Late Surgery Group. Preoperative serum levels of creatinine, blood urea nitrogen (BUN), and glomerular filtration rates (GFR) were recorded for the patients in both groups. In the postoperative first month, serum creatinine, BUN, and GFR were again recorded and compared with the preoperative values.
Results: The mean preoperative serum creatinine, GFR, and BUN levels in the Early Surgery Group were 1.25 ± 0.65µmol/L, 80.04 ± 33.6ml/min/1.73m2, and 50 ± 16.6mmol/L, respectively. A decrease was observed in serum creatinine (0.82 ± 0.22µmol/L, p< 0.001) and BUN (14.08 ± 7.25mmol/L, p< 0.001) levels one month after surgery, whereas GFR increased (105.33 ± 21.6ml/min/1.73m2, p< 0.001). In the Late Surgery Group, postoperative levels of serum creatinine (0.94 ± 0.33 vs. 0.95 ± 0.30µmol/L, p= 0.102), and BUN (17.38 ± 9 vs. 17.92 ± 8.8mmol/L, p= 0.283), increased minimally, also a minimal decrease was observed in GFR (95.15 ± 27.3 vs. 93.77 ± 24.3ml/min/1.73m2, p= 0.338) without any statistically significant difference.
Conclusion: We believe that surgical treatment should be planned within two weeks at the latest, as prolonged obstruction may result in kidney damage.

Keywords: ureterorenoscopic stone removal, ureteroscopy, ureter stone, kidney function, medical expulsive therapy

Öz

Amaç: Üreterorenoskopik taş çıkarma cerrahisi zamanlamasının böbrek fonksiyonları üzerine etkisinin incelenmesi.
Gereçler ve Yöntemler: Çalışmaya dahil edilen 137 hasta iki gruba ayrıldı. 98 hastaya taş tanısından sonra 14 gün veya daha kısa sürede cerrahi uygulanırken (Erken Cerrahi Grubu), 39 hastaya (Geç Cerrahi Grubu) ise taş tanısını takiben 14 günden daha uzun sürede cerrahi uygulanmıştı. Preoperatif serum kreatinin, kan üre nitrojeni (BUN), tahmini glomerüler filtrasyon hızı (GFR) her hasta için kayıt edildi. Postoperatif birinci ayda serum kreatinin, BUN ve GFR değerleri, ilk ölçümlerle karşılaştırıldı.
Bulgular: Erken cerrahi grubunda ortalama serum kreatinin, GFR ve BUN seviyeleri sırasıyla 1,25 ± 0,65µmol/L, 80,04 ± 33,6ml/dk/1.73m2, 50 ± 16,6mmol/L idi. Operasyon sonrası birinci aydaki serum kreatinin (0,82 ± 0,22µmol/L, p< 0,001) ve BUN (14,08 ± 7,25mmol/L, p< 0,001) seviyelerinde düşüş izlenirken, GFR'de (105,33 ± 21,6ml/min/1.73m2, p< 0,001) artış tespit edildi. Geç cerrahi grubunda serum kreatinin (0.94 ± 0,33'e karşı 0,95 ± 0,30µmol/L, p = 0,102) ve BUN (17,38 ± 9'e karşı 17,92 ± 8,8mmol/L, p= 0,283) seviyesinde minimal artış ve GFR ölçümlerinde (95,15 ± 27,3'e karşı 93,77 ± 24,3ml/dk/1,73m2, p= 0,338) minimal ve istatistiksel açıdan anlamlı olmayan azalma izlenmiştir..
Sonuç: Üreter taşlarında cerrahi tedavinin en geç iki hafta içinde planlanması gerektiğini düşünüyoruz. Cerrahi tedavinin geciktirilmesi böbreklerin hasarlanmasına neden olabilir.

Anahtar kelimeler: üreterorenoskopik taş çıkarma, üreteroskopi, üreter taşı, böbrek fonksiyonu, medikal ekspulsif terapi

ORCID ID: M.A. Karadag 0000-0002-2454-8850

Introduction

Worldwide, the prevalence of urinary system stone disease has been reported to vary between 1% and 20% [1]. Urinary system stones are treated according to their size, their anatomical location, and the complications they cause. Treatment options for ureteral stones include observation, medical expulsive therapy (MET), extracorporeal shock wave lithotripsy (ESWL), percutaneous antegrade ureteroscopy, retrograde ureteroscopy, and open or laparoscopic ureterolithotomy [2]. The treatment alternative chosen will depend on the location and size of the stone, the available technology, the treatment costs, the surgeon's experience and the patient's preference [3].

A meta-analysis has revealed that 68% of stones smaller than 5mm can pass spontaneously. This rate decreases to 47% for stones 5–10 mm in size [4]. The location of the stone is also an important factor in the possibility of spontaneous passage; 48% of proximal ureteral stones, 60% of middle ureteral stones, and 75% of distal ureteral stones may pass spontaneously [5]. For small ureteral stones, when there is no sign of infection and when the symptoms can be controlled, waiting for the stone to pass spontaneously is a good option. This approach also protects the patient from invasive surgical procedures and unnecessary costs. MET is an effective treatment approach for this patient group [6]. The MET method should not be used for stones larger than 10 mm [7].

It is still unclear exactly how long the waiting period will be between observation or MET and spontaneous stone passage. According to various studies, this period usually ranges from two to six weeks [8,9]. In patients with complete renal obstruction, urinary diversions may save kidney functions within a week, but, even if the obstruction is resolved, kidney functions may not recover for longer periods [10].

In this study, we aimed to evaluate the effects of ureteorenoscopic stone removal on kidney function in unilateral ureteral stones.

Materials and Methods

Patient Selection

Local ethics committee approval was obtained prior to study (approval number: 2021/385). This retrospective study analyzed data from 259 patients, who underwent URS for unilateral ureteral stones at Kayseri City Hospital between June 2017 and December 2020. Patients were excluded from the study if their serum creatinine values, and glomerular filtration rate (GFR) were unknown during the postoperative period, if computed tomography had not been used to diagnose their unilateral ureteral stones, if their GFR measures were ≤ 60, or if their stone sizes were > 10mm. The patients for whom the location and size of the stone could not be determined on preoperative radiological imaging (n:44), patients with stones larger than 10 mm (n:30), cases with GFR below 60 ml/min/1.73 m2 (n:27) and 21 patients with missing data were excluded from the study. In total, 137 patients were included in the study.

Study Design

The sampled patients were divided into two groups: those who underwent surgical intervention at ≤14 days (Early Surgery Group) and at >14 days after stone diagnosis (Late Surgery Group). Although there are studies stating the duration of observation and MET treatments between two and six weeks [8,9], we determined 14 days as the cut- off value in our study. Preoperative levels of serum creatinine, blood urea nitrogen (BUN), and glomerular filtration rate (GFR), location of stones in the ureters, the degree of hydronephrosis, age, gender of the patients, and time of diagnosis were recorded. The GFR was calculated for each patient based on the modification of Diet in Renal Diseases Study Formula (GFR=186 * [serum creatinin] -1.154 X [age] – 0.203 [if female] * 0.742 [if African American] * 1.212). The severity of hydronephrosis was graded according to the anteroposterior diameter of the renal pelvis as follows: Grade 1 (5-10 mm), Grade 2 (10-15 mm), Grade 3 (15-20 mm), and Grade 4 (>20 mm). In the postoperative first month, serum creatinine, BUN, and GFR were again recorded and compared with the preoperative values.

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) for Windows, version 25.0 (IBM SPSS, Armonk, NY, USA). Normal distribution of the continuous variables was analyzed using the Shapiro–Wilk test and histograms. Continuous variables with normal distribution were expressed as mean ± standard deviation (SD). In independent groups, the continuous variables with normal distribution were compared using Student's t test. Identification rates were also compared using Pearson's chi-squared test. A p-value of <0.05 was considered significant.

Results

In total, 137 (98 in the Early Surgery Group and 39 in the Late Surgery Group) patients were sampled. The mean age of the 96 patients in the Early Surgery Group was 43.62 ± 13.9 years including 38 (39.6%) female, and 58 (60.4%) male patients. The mean age of the 39 patients in the Late Surgery Group was 46.46 ± 13.7 years; including 12 (30.8%) female, and 27 (69.2%) male patients. In the Early, and Late Surgery Groups mean time intervals between the stone diagnosis and surgery were 5.4 ± 3.11, and 27.79 ± 15.35 days, respectively (p< 0.000). **Table 1** presents the participants' demographic and clinical data. A decrease was observed in serum creatinine (0.82 ± 0.22µmol/L, p< 0.001) and BUN (14.08 ± 7.25mmol/L, p< 0.001) levels one month after surgery and the GFR increased (105.33 ± 21.6ml/min/1.73m2, p< 0.001) in the Early Surgery Group. **Table 2** presents the pre- and postoperative parameters for the Early Surgery Group. In the Late Surgery Group, postoperative serum creatinine levels increased minimally (0.94 ± 0.33 vs. 0.95 ± 0.30µmol/L, p= 0.102), but GFR decreased (95.15 ± 27.3 vs. 93.77 ± 24.3ml/min/1.73m2, p= 0.338). Although there was an increase in BUN (17.38 ± 9 vs. 17.92 ± 8.8mmol/L, p= 0.283) values, the intergroup different was not statistically significant. **Table 3** depicts the pre- and post-operative parameters for the Late Surgery Group.

Table 1. Demographic and clinical characteristics of the patients

		Early Surgery Group		Late Surgery Group		
		Mean	**n (%)**	**Mean**	**n (%)**	**P-value**
Age (years)		43.62 (±13.9)		46.46 (±13.7)		0.285
Gender	Female		38 (39.6)		12 (30.8)	0.336
	Male		58 (60.4)		27 (69.2)	
Hydronephrosis	Grade 1-2		54 (56.3)		23 (59.0)	0.599
	Grade 3-4		42 (43.8)		16 (41.0)	
Localization of ureteral stones	Proximal		20 (20.8)		8 (20.5)	0.917
	Middle		28 (29.2)		11 (28.2)	
	Distal		48 (50.0)		20 (51.3)	
Preoperative serum creatinine (µmol/L)		1.25 (±0.65)		0.94 (±0.33)		**0.006**
Preoperative glomeruler filtration rate (ml/min/1.73m^2)		80.04 (±33.6)		95.15 (±27.3)		**0.014**
Preoperative blood urea nitrogen (mmol/L)		19.50 (± 16.6)		17.38 (±9.1)		0.455
Time to surgery (days)		5.45 (± 3.11)		27.79 (±15.35)		**0.000**

Table 2. Pre- and postoperative serum levels and glomerular filtration rates of the patients in the Early Surgery Group

	Preoperative	**Postoperative**	**P-value**
Serum creatinine (µmol/L)	1.25 (± 0.65)	0.82 (± 0.22)	**<0.001**
Glomeruler filtration rate (ml/min/1.73m2)	80.04 (± 33.6)	105.33 (± 21.6)	**<0.001**
Blood urea nitrogen (mmol/L)	19.50 (± 16.6)	14.08 (± 7.25)	**<0.001**

Table 3. Pre- and postoperative serum creatinine levels and glomerular filtration rates of the patients in the Late Surgery Group

	Preoperative	**Postoperative**	**P-value**
Serum creatinine (µmol/L)	0.94 (± 0.33)	0.95 (± 0.30)	0.102
Glomeruler filtration rate (ml/min/1.73m^2)	95.15 (± 27.3)	93.77 (± 24.3)	0.338
Blood urea nitrogen (mmol/L)	17.38 (± 9.0)	17.92 (± 8.8)	0.283

Discussion

Urinary stone disease is an important public health problem in both adults and children. Recurrence is seen in one out of every three patients with urinary stone [11]. Urinary system stones may cause damage to the nephrons. Recurrent stones may lead to the development of a non-functioning kidney as an end-stage complication [12]. As a subgroup of urinary systems stones, ureteral stones can ensue in renal damage by causing ureteral obstruction [13]. Application of diversion in the first week after complete ureteral obstruction provides almost complete recovery of renal functions. While partial improvement was observed in renal functions in the diversions performed until the 12th week, the renal functions did not recover after urinary diversions performed after the 12th week [10]. In a study conducted in rabbits, blood perfusion had decreased in the first period in the obstructed kidney, there was a sharp rebound after a few days and then decreased again. The average rebound time in blood flow was 7.2 days [14]. Normally, it is accepted that a single morphologically and physiologically normal kidney is sufficient to perform all renal functions [15]. Therefore, unilateral ureteral obstructions do not usually cause renal dysfunction in healthy individuals. However, many patients may have abnormal renal function test results with normal contralateral kidney due to unilateral obstruction [16]. Similarly, although the contralateral kidneys of the patients were morphologically normal in our study, improvement in renal function tests was observed in patients in the Early Surgery Group.

Patients with unilateral obstruction and normal functioning contralateral kidneys demonstrate more frequently urinary dysfunction than patients with a single kidney [17]. In a prospective observational study on 152 patients; acute renal damage has been reported in 37 (29%) of 126 patients with unilateral ureteral stones. Renal recovery has been reported in

72% -100% of the cases after ureteral stone surgery. It has been shown that early intervention is associated with higher recovery rates [18]. Likewise, improvement in renal functions was observed in our Early Surgery Group, whereas renal recovery was not observed in the Late Surgery Group.

Although noninvasive treatments such as observation and medical expulsive therapy (MET) are being used in the treatment of ureteral stones, there is no consensus on duration of these treatments, and selection of eligible patients. In the studies in the literature, MET was generally performed between 2 and 6 weeks prior to surgery. MET has been accepted to have unsuccessful outcomes for varying periods of time depending on the center administering the treatment [9]. Lack of a consensus on appropriate timing for uterorenoscopy or urinary diversion has led to different approaches. In our study, a serious improvement was observed in kidney functions in the group of patients who were selected for early surgical treatment, while any change in renal functions was not detected in the Late Surgery Group. Delaying surgical management of an ureteral stone for MET or any other reason may result in renal damage. This important issue should be taken into consideration when treating patients using alternatives other than urinary diversion.

The weaknesses of our study can be listed as its retrospective design, insufficient number of patients, and the inability to standardize the groups in terms of their renal functions. Although prospective randomized studies on this issue are required, delaying surgical treatment may cause ethical problems. Application of different treatment approaches to standard groups under the same conditions is not accepted by the local ethics committee. For this reason, our study was designed retrospectively. Although the groups in our study were similar in terms of age, gender, stone location, degree of hydronephrosis, blood urea level, a significant intergroup difference was found between them in terms of preoperative serum creatinine levels and glomerular filtration rates. It was thought that as the renal dysfunction worsened, clinicians might have drifted away from observation and medical treatment which explains why the groups could not be standardized in this respect. There are not enough studies in the literature regarding the timing of surgery in ureteral stones. Therefore, multicenter studies in larger patient groups are required.

Conclusion

Treatment methods such as observation and MET applied to patients in order to reduce the morbidity caused by surgery do not eliminate obstruction. In addition, there is no consensus yet on how long these treatments will be applied. We believe that surgical treatment should be planned within two weeks at the latest, as prolonged obstruction may result in kidney damage.

Ethics Committee Approval: The study was approved by the Ethics Committee of Kayseri City Education and Research Hospital (Approval Date, and Registration Number: 04.29. 2021/385).
Informed Consent: An informed consent was obtained from all the patients.
Publication: The results of the study were not published in full or in part in form of abstracts.
Peer-review: Externally peer-reviewed.
Authorship Contributions: There is not any contributions who may not be listed as authors. Concept – A.S.G., M.A.K.; Design – A.S.G., M.A.K.; Supervision – A.S.G., M.A.K.; Resources – A.S.G., M.A.K.; Materials – A.S.G., M.A.K.; Data Collection and/or Processing – A.S.G., M.A.K.; Analysis and/or Interpretation – A.S.G., M.A.K.; Literature Search – A.S.G., M.A.K.; Writing – A.S.G., M.A.K.; Critical Review – A.S.G., M.A.K.
Conflict of Interest: The authors declare that they have no conflict of interest.
Financial Disclosure: The authors declare that this study received no financial support.

References

[1] Ramello A, Vitale C, Marangella M. Epidemiology of nephrolithiasis. J Nephrol 2000;13:S45-50. https://pubmed.ncbi.nlm.nih.gov/11132032/.

[2] Shafi H, Moazzami B, Pourghasem M, Kasaeian A. An overview of treatment options for urinary stones. Casp J Intern Med 2016;7:1–6. https://pubmed.ncbi.nlm.nih.gov/26958325/.

[3] Bensalah K, Pearle M, Lotan Y. Cost-Effectiveness of Medical Expulsive Therapy Using Alpha-Blockers for the Treatment of Distal Ureteral Stones. Eur Urol 2008;53:411–8. https://doi.org/10.1016/j.eururo.2007.09.012.

[4] Preminger GM, Tiselius HG, Assimos DG, Alken P, Buck C, Gallucci M, et al. 2007 Guideline for the Management of Ureteral Calculi. J Urol 2007;178:2418–34. https://doi.org/10.1016/j.juro.2007.09.107.

[5] Coll DM, Varanelli MJ, Smith RC. Relationship of spontaneous passage of ureteral calculi to stone size and location as revealed by unenhanced helical CT. Am J Roentgenol 2002;178:101–3. https://doi.org/10.2214/ajr.178.1.1780101.

[6] Lotan Y, Cadeddu JA, Pearle MS. International comparison of cost effectiveness of medical management strategies for nephrolithiasis. Urol Res 2005;33:223–30. https://doi.org/10.1007/s00240-005-0463-9.

[7] Wood KD, Gorbachinsky I, Gutierrez J. Medical expulsive therapy. Indian J Urol 2014;30:60–4. https://doi.org/10.4103/0970-1591.124209.

[8] Picozzi SCM, Marenghi C, Casellato S, Ricci C, Gaeta M, Carmignani L. Management of ureteral calculi and medical expulsive therapy in emergency departments. J Emerg Trauma Shock 2011;4:70–6. https://doi.org/10.4103/0974-2700.76840.

[9] Pickard R, Starr K, MacLennan G, Lam T, Thomas R, Burr J, et al. Medical expulsive therapy in adults with ureteric colic: A multicentre, randomised, placebo-controlled trial. Lancet 2015;386:341–9. https://doi.org/10.1016/S0140-6736(15)60933-3.

[10] Vaughan ED, Marion D, Poppas DP, Felsen D.

Pathophysiology of unilateral ureteral obstruction: Studies from Charlottesville to New York. J Urol 2004;172:2563–9. https://doi.org/10.1097/01.ju.0000144286.53562.95.

[11] Kirkali Z, Rasooly R, Star RA, Rodgers GP. Urinary Stone Disease: Progress, Status, and Needs. Urology 2015;86:651–3. https://doi.org/10.1016/j.urology.2015.07.006.

[12] Shrestha A, Chhettri P, Yadav BK, Basnet RB, Shrestha PM. Urinary Stone Disease and Preventable Nephrectomies. J Nepal Health Res Counc 2019;17:238–41. https://doi.org/10.33314/jnhrc.v0i0.1996.

[13] Kato T, Hamano A, Kawamura H. Acute renal failure due to obstructive ureteral stone associated with norovirus gastroenteritis in an infant with congenital solitary kidney. Nihon Hinyokika Gakkai Zasshi 2014;105:224–8. https://doi.org/10.5980/jpnjurol.105.224.

[14] Wang C, Gao C, Maimaiti W, Li S, Yang Q, Jiang L. The features of technetium-99m-DTPA renal dynamic imaging after severe unilateral ureteral obstruction in adult rabbits. PLoS One 2020;15:e0237443. https://doi.org/10.1371/journal.pone.0237443.

[15] Regazzoni BM, Genton N, Pelet J, Drukker A, Guignard JP. Long-term followup of renal functional reserve capacity after unilateral nephrectomy in childhood. J Urol 1998;160:844–8. https://doi.org/10.1016/S0022-5347(01)62817-9.

[16] Al-Ani A, Al-Jalham K, Ibrahim T, Majzoub A, Al-Rayashi M, Hayati A, et al. Factors determining renal impairment in unilateral ureteral colic secondary to calcular disease: a prospective study. Int Urol Nephrol 2015;47:1085–90. https://doi.org/10.1007/s11255-015-0986-0.

[17] Marniemi J, Parkki MG. Radiochemical assay of glutathione S-epoxide transferase and its enhancement by phenobarbital in rat liver in vivo. Biochem Pharmacol 1975;24:1569–72. https://doi.org/10.1016/0006-2952(75)90080-5.

[18] Mahmud HM, Mahmud SM. Acute kidney injury in ureteric stones: Single centre short term analysis. Pakistan J Med Sci 2017;33:808–12. https://doi.org/10.12669/pjms.334.13345.