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The Effects of Ureterorenoscopy on Renal Function

Mustafa Aldemir, Efe Önen, Önder Kayıgil
Department of 2nd Urology, Ankara Atatürk Teaching and Research Hospital, Ankara, Turkey
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ABSTRACT

INTRODUCTION: The effects of dilatation and increased pressure in the ureter and renal pelvis following ureterorenoscopy (URS) are not well documented. The purpose of the prospective study was to evaluate renal function in patients undergoing URS for treatment of ureteral calculi.

METHODS: URS was performed on 30 patients between March and June, 2009. The mean (SD) patient age was 38.8 (12.2) years. There were 23 males and 7 females. Biochemical tests of renal function in the serum and urine were performed before the URS and on the 7th postoperative day. Outcome measures were compared before and after URS for all patients, and separately for patients with or without a double-J stent, using paired *t* tests. Probability < .003 indicated significant differences, following a Bonferroni adjustment.

RESULTS: Out of 17 measures of renal function, there was a significant postsurgery increase in the amount of proteinuria excreted in the 24-hour urine (P = .001). Ureteral stents were inserted in 19 (63%) patients. Patients with and without DJ stents had a significant increase in proteinuria in 24-hour urine (P = .001 for both patient groups). There were no other significant differences. The mean URS duration was 40 minutes. The mean amount of serum physiological fluid consumed was 1860 mL (SD, 1474.2; range, 250-7500 mL). A pneumatic lithotripter was used in 27 (90%) of the cases to shatter the calculi. There were no surgical complications or significant changes in arterial blood pressure.

CONCLUSIONS: The URS procedure did not significantly alter any measure of renal function except for urine proteinuria in 24 hours, which increased following surgery for patients with or without DJ stents.

INTRODUCTION

Ureterorenoscopy (URS) is an endoscopic procedure that is used for the diagnosis and treatment of renal and ureteral calculi, foreign bodies, filling defects, and tumors. It is also used for the assessment of ureteric obstructions and congestions, unexplained cases of hematuria, positive urine cytologies, and ureteral fistulae [1].

An increase in the level of renal pelvic pressure occurs from the use of irrigation solution during URS. This pressure could result in rupture of the collective system as well as intrarenal, pyelovenous, and pyelolymphatic backflow. It was demonstrated in pigs that performing URS under high-pressure irrigation has detrimental effects on the renal parenchyma and increases the risk of bacteriemia and sepsis development [2]. However, the effects of dilatation and increased pressure in the ureter and renal pelvis following URS are not well documented in humans. The purpose of the present study was to compare renal function in patients before and after URS for the treatment of ureteral calculi.

METHODS

The prospective study was approved by the review board of the authors' institution. Written consent was obtained from

KEYWORDS: Ureterorenoscopy; Renal functions; Ureteral stent
CORRESPONDENCE: Mustafa Aldemir, MD, Aydınlıkevler Mahallesi Arılık Sokak No: 5/5, P.O. Box 06130, Ankara, Turkey (drmaldemir@mynet.com).
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Abbreviations and Acronyms
CRP = c-reactive protein
DJ = double J
URS = ureterorenoscopy

the participants. The study was conducted between March 2009 and June 2009.

Participants

The participants were 30 patients with ureteral calculi. The mean (SD) age of the patients was 38.8 years (SD, 12.2; range, 19-62 years). There were 23 males and 7 females. Exclusion criteria included: (1) patients with renal insufficiency, anuria, oliguria, or hepatic impairment; (2) patients on medications that affect renal functions, including nephrotoxic or diuretic medications; (3) patients with the diagnosis of heart failure, renal disease, or urinary system infection.

The ureteric stones ranged in size from 6-18 mm. Their location was: 16 (53.3%) in the right ureter and 14 (47.7%) in the left ureter. The level of the ureteric stones was: 19 (63.3%) lower ureter, 7 (23.3%) middle ureter, and 4 (13.3%) upper ureter.

Procedures

All patients had a URS procedure. It was performed with a single working channel, rigid ureterorenoscope (Karl Storz; Tuttlingen, Germany) with a 6° lens and a length of 43 cm. The patients received anesthesia and were placed in the lithotomy position. The height between the renal level and irrigation liquid was 70 cm. Neither a manual syringe nor a mechanical cylindrical-pumping device was used during the procedures. A double-J (DJ) ureteral stent was inserted, as needed.

Data Analysis

The duration of the URS operation, amount of irrigation liquid consumed, and number of patients needing insertion of DJ ureteral stents were recorded.

Biochemical tests of renal functions were performed before the URS and on the 7th postoperative day. These tests were used to examine each patient's serum urea, creatinine, sodium, potassium, calcium, potassium, magnesium, chloride, c-reactive protein (CRP), and renin. Other measures were blood hemoglobin, white corpuscle, and trombocyte levels. Urea in the urine excreted in 24-hours, urine pH, density, creatinine clearance, and urine protein were also examined. Finally, the arterial blood pressure of the patients was assessed.

SPSS 11.5 for Windows (Chicago, IL, USA) was used to analyze

Table 1. Results of Biochemical Tests of Renal Function Performed Before Ureterorenoscopy and on the 7th Postoperative Day; Probability of Significant Differences (N = 30). doi: 10.3834/uij.1944-5784.2010.10.07t1

Outcome Measure	Presurgery		Postsurgery		*P*
	Mean	SD	Mean	SD	
Serum urea, mg/dL	31.5	8.9	26.6	6.9	.03
Serum creatinine, mg/dL	0.9	0.3	0.9	0.2	>.05
Serum sodium, mmol/L	140.2	2.8	138.9	2.1	>.05
Serum calcium, mg/dL	9.1	0.7	9.2	0.5	>.05
Serum potassium, mmol/L	4.2	0.3	4.2	0.3	>.05
Serum magnesium, mg/dL	1.9	0.3	1.9	0.2	>.05
Serum chloride, mmol/L	104.4	3.5	103.7	2.3	>.05
Serum c-reactive protein, mg/L	6.9	5.7	8.2	7.7	>.05
Blood hemoglobin, g/dL	14.4	1.3	14.3	1.2	>.05
Blood leukocyte, K/µL	7.5	2.0	7.4	1.3	>.05
Blood platelet, K/µL	270.2	64.3	275.6	56.2	>.05
Urine pH	5.9	0.7	5.8	0.7	>.05
Urine density	1018.9	8.5	1017.2	5.7	>.05
Excreted urine, mL/24h	2066.6	829.8	2567.7	1143.5	.05
Creatinine clearance, mL/dk/24h	85.5	50.1	110.0	34.2	.03
Urine proteinuria, g/L/24h	0.2	0.5	1.7	0.5	.001
Serum renin, ng/mL/h	0.9	0.4	1.5	1.0	.02

the data. Paired-sample *t* tests were used to compare the presurgical with postsurgical outcome measures, and to compare cases undergoing DJ ureteral stent implant with those not undergoing DJ stenting. All probability levels are reported. However, because there were 17 paired comparisons, a Bonferroni adjustment was applied to avoid type I error. This resulted in α =.003. A power analysis was not conducted. Therefore, the possibility of type II error exists for this sample size.

RESULTS

The mean URS duration was 40 minutes (SD, 12.9; range, 15-60 minutes). The mean amount of serum physiological fluid consumed during URS was 1860 mL (SD, 1474.2; range, 250-7500 mL). A pneumatic lithotripter was used in 27 (90%) of the cases to shatter the calculi. DJ stents were inserted in 19 (63.3%) patients.

Of the total 30 patients, 90% were stone free and 10% had clinically insignificant residual stones (< 4 mm in size). No complication occurred from the URS procedures in any of the cases. There was no significant change in arterial blood pressure.

Table 1 contains the results of the biochemical evaluations for all patients, conducted before URS and 7 days after URS. The probability of significant presurgery and postsurgery differences is also reported. There was a significant postsurgery increase in the amount of proteinuria excreted in the 24-hour urine (*P* = .001). There were no significant differences in any other variables (*P* > .003).

Table 2 contains the results of the biochemical evaluations for patients with DJ stents (n = 19) and patients without DJ stents (n = 11) and the probability of significant differences. Patients with and without DJ stents had a significant increase in proteinuria in 24-hour urine (*P* = .001 for both patient groups). No other significant differences were found.

Table 2. Results of Biochemical Tests of Renal Function Performed Before and After Ureterorenoscopy for Patients With and Without Double-J Stents; Probability of Significant Differences (N = 30).
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Outcome Measure	Patients With Double-J Stent (n = 19)					Patients Without Double-J Stent (n = 11)				
	Presurgery		Postsurgery		*P*	Presurgery		Postsurgery		*P*
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Serum urea, mg/dL	31.8	10.0	26.7	5.4	>.05	30.9	7.2	26.5	9.2	>.05
Serum creatinine, mg/dL	0.9	0.3	0.9	0.2	>.05	1.0	0.3	0.9	0.2	>.05
Serum sodium, mmol/L	140.7	2.5	139.2	2.0	>.05	139.3	3.2	138.4	2.2	>.05
Serum calcium, mg/dL	9.2	0.5	9.2	0.6	>.05	8.9	0.9	9.2	0.4	>.05
Serum potassium, mmol/L	4.2	0.4	4.2	2.4	>.05	4.2	0.3	4.2	0.3	>.05
Serum magnesium, mg/dL	1.9	0.4	1.9	0.2	>.05	1.8	0.2	1.9	0.1	>.05
Serum chloride, mmol/L	104.2	3.7	104.2	2.5	>.05	104.9	3.2	102.8	2.3	>.05
Serum c-reactive protein, mg/L	6.2	3.5	9.1	9.2	>.05	8.3	8.2	6.8	4.0	>.05
Blood hemoglobin, g/dL	14.6	1.4	14.3	1.1	>.05	13.9	1.1	14.2	1.4	>.05
Blood leukocyte, K/µL	7.1	2.1	7.5	1.2	>.05	8.2	1.8	7.4	1.5	>.05
Blood platelet, K/µL	270.2	64.3	275.6	56.2	>.05	268.2	77.9	275.2	57.8	>.05
Urine pH	5.9	0.8	5.7	0.7	>.05	5.7	0.5	6.0	0.8	>.05
Urine density	1017.3	8.5	1016.8	5.4	>.05	1021.8	7.9	1018.0	6.3	>.05
Excreted urine, mL/24h	2231.6	875.2	2760.0	1288.2	>.05	1781.8	691.1	2235.5	783.1	>.05
Creatinine clearance, mL/dk/24h	87.1	40.6	114.0	40.8	.04	82.7	65.6	103.2	17.9	>.05
Urine proteinuria, g/L/24h	0.2	0.5	1.6	0.5	.001	0.1	0.3	1.8	0.4	.001
Serum renin, ng/mL/h	0.9	0.4	1.4	1.1	>.05	0.9	0.5	1.6	0.8	.04

DISCUSSION

Normal renal pelvic pressure varies between 5-15 mmHg [2,3]. The pressure can rise to approximately 410 mmHg during URS. This pressure is affected by the type of surgical instrumentation used, the height of the medical irrigation pouch, use of manual injection syringe or mechanical cylindrical pumping device, or the fullness level of the bladder during the operation [2,4]. In a study in pigs, renal pelvic pressure was measured between 28-122 mmHg depending on the fullness of the bladder and the height of the irrigation pouch [2]. Another study using human patients showed that this pressure rose to 345-410 mmHg when a manual injection syringe was used with irrigation [4]. The authors suggested that this pressure could result in renal pelvic rupture and septic complications.

Boccafoschi et al [5] demonstrated that intrarenal reflux occurred on human cadaver kidneys at pressures under 30 mmHg. They also showed that when the intrarenal pressure was raised to 37-52 mmHg, pyelovenous reflux occurred; this refux is typically related to infection. Pyelotubular reflux was observed at 22-30 mmHg pressure in their study. Michel et al [6] suggested a relationship between clearance of the irrigation liquid pouch from the renal level and intrapelvic pressure. They demonstrated that during conventional URS, the pressure reached a mean (SD) of 40 (3.3) cm at a height of 50 cm, and pyelolymphatic and pyelovenous backflow occurred.

Previous studies have been designed to determine backflows that alter renal pressure on animal and human kidneys during URS. It is obvious from their results that a pressure increase occurs in the renal pelvis during the URS procedure that leads to backflow toward the renal parenchyma, lymphatic, and venous systems. The effects on renal functions were examined previously on the 7th postoperative day in patients diagnosed with unilateral hydronephrosis [7]. Similarly, the renal functions of patients with ureteral calculi in the present investigation were evaluated on the 7th day after URS.

The clearance of the irrigation liquid pouch from the renal level was 70 cm in the present study. Therefore, we assume that pyelolymphatic and pyelovenous backflow occurred, as previously proven with the conventional URS device [6]. However, the backflow did not result in surgical complications. Patients with urinary infections were not included in our study and there were no complications due to infection following URS. No significant alteration in the number of white corpuscles or levels of CRP occurred. Similarly, significant alterations in the electrolyte levels that display the excretion functions of the kidney were not observed.

Normally, increase in the renal pelvic pressure stimulates the synthesis of prostaglandins in the kidneys. These prostaglandins cause a temporary increase in renal blood flow and pelvic pressure. Prostaglandin inhibitors suppress this effect [8]. In the present study, we hypothesize that the serum renin levels did not change significantly following URS because of this suppression; the patients were taking diclofenac as an analgesic. From the clinical point of view, no significant pre-URS and post-URS differences in the blood pressures of the patients were observed.

Although there was a considerable increase in urine output after the URS procedures, this increase was not statistically significant. In this study, the URS applications were performed in patients with ureteral calculi. The amount of urine could be raised due to removal of the obstructing calculi. Furthermore, patients may have consumed excessive amounts of liquids after the URS procedures.

We performed multiple accesses to the ureter. These applications might have resulted in erosions in the ureter, bladder, and urethra mucosa, thereby causing the significant increase in the proteinuria level following URS. Our study was conducted in patients with ureteral stones. Following removal of the ureteral stones by URS, ureteral obstruction was resolved. This might have increased the glomerular filtration rate, as compared with the preoperative obstructed state.

We examined the potency of DJ stent application in preventing possible pressure increase in the renal pelvis. We believe that the DJ stent promotes the urine flow and prevents the temporary edema-oriented obstructions that may form in the ureteric orifice. We think that DJ stenting could be useful, particularly when surgery is of long duration or when pressure-increasing devices such as the mechanical cylindrical pump are applied.

CONCLUSIONS

The URS procedure is frequently performed in patients with ureteral calculi. This procedure did not significantly change any measure of renal function except for urine proteinuria in 24 hours, which increased following surgery for patients with or without DJ stents. Some additional outcome measures approached statistical significance and may be of interest in future studies.

Conflict of Interest: none declared

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