Renal vascular changes detected post Ureteroscopy in patients with lower ureteric stones.

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Abstract: **Background:** Color duplex ultrasonography is a safe and an efficient method to evaluate intrarenal hemodynamics that are thought to result from the utilization of Ureteroscopy. **Objective:** The aim of this study was to evaluate the renal vascular parameter changes accompanied with the use of rigid ureteroscopy as a modality of treatment of patients suffering lower ureteric stones. **Patients and methods:** Thirty patients with lower ureteric stones not larger than 1 cm in diameter and hydronephrosis not more than grade 1 (otherwise excluded) were prospectively studied via the application of color Doppler ultrasonography (CDUS). Patients were evaluated via CDUS on the preoperative day, one day postoperative and one month after the ureteroscopy. Parameters studied were the resistive index (RI), pulsatility index (PI), peak systolic velocity (PSV) and the end diastolic velocity (EDV). Changes in these values (ΔRI, ΔPI, ΔPSV and ΔEDV) were measured and compared on the first postoperative day and one month after the URS was performed. The degree of hydronephrosis and location of stones in the obstructed kidneys, diameters of both kidneys, and thickness of renal parenchyma were evaluated with gray-scale US preoperatively. **Results:** There were significant increase in the RI and the PI values on the first postoperative day (9 % increase in the RI and 13.5 % increase in the PI). However, there was no significant increase in these values for the normal non-operated kidneys. In Spearman correlation coefficient analysis, ΔRI was found to be correlated with the parameters: "operative time" and "irrigation fluid volume". On reassessing Doppler parameters for the operated kidneys after one month duration, both the RI and the PI decreased by 5 % and 8.9 % respectively. There was no significant relation between ΔRI and any of the other evaluated parameters; i.e. age, gender, degree of hydronephrosis and side of URS. **Conclusion:** Ureteroscopy in itself can cause an increase in the renal vascular resistance leading to a decrease in the renal blood flow as evidenced by increase in the RI on the postoperative day. This measured in RI increased proportionally with the amount of irrigation fluid used and the duration of the Ureteroscopy. However, the increase in the renal vascular parameters was of a temporary nature as RI values returned below the preoperative values for the operated kidneys.

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1. Introduction

Ureteroscopy is the preferred approach for the surgical treatment of ureteral stones with low complication and high success rates (Anagnostou and Tolley 2004; Preminger et al. 2007; Yencilek et al. 2010). Routinely, during an URS operation, irrigation fluid is infused through the ureteroscope in order to visualize the ureter. Therefore, an increased intraureteral and intrapelvic pressure could be expected during this operation(Abrahams et al. 2004). It's been hypothesized that URS operation would increase renal vascular resistance and cause functional hemodynamic changes in the kidney that can be detected by color duplex ultra-sonography. Today, ultrasonography is regarded as a non-invasive, quick, inexpensive, and reproducible diagnostic method for the evaluation of obstructive uropathy. However, it cannot be used for functional evaluation. Therefore, dynamic US evaluation of kidneys with color duplex ultra-sonography may provide information about functional hemodynamic changes earlier than anatomical changes. Even after 2 hours of renal obstruction, those hemodynamic changes might be demonstrated with color duplex ultra-sonography(Akçar et al. 2004; Amirthalingam 2014).

2. Patients and Methods

After the approval of the hospital ethic committee was obtained, we prospectively studied thirty patients who underwent rigid ureteroscopy as a line of treatment of lower ureteric stones with a diameter of less than 10 mm. All of the patients were managed at the Urology Department of AL AZHAR University Hospitals "SAYED GALAL and AL-HUSSEIN Hospitals". Preoperatively, all patients were assessed thoroughly via history taking, physical examination, laboratory investigations and radiological examination. Laboratory investigations included mainly complete blood count (CBC), Kidney function tests; blood urea, blood creatinine, Liver function tests; ALT, AST, Bilirubin (total & direct), Albumin, GGT and alkaline phosphatase, and finally blood coagulation profile: PT, PTT and INR. Radiological examination included an abdominal (renal) ultrasound plus either a CT urinary tract (CTUT) or an intravenous pyelogram (IVP). However, in selected cases, both radiological studies (CTUT and IVP) were obtained as per needed to formulate an accurate diagnosis. No patient in our study group was known to have suffered prior renal vascular disease, renal failure, diabetes mellitus, or liver disease. In addition, no patient had prior open or percutaneous renal surgery on either operated side or contralateral kidneys. Otherwise, the patients were excluded from the study. The degree of hydronephrosis and location of the stone (if visible) in the obstructed kidney, diameters of both kidneys, and thickness of renal parenchyma were evaluated with conventional gray-scale ultrasound. On the day before the ureteroscopy, color Doppler ultrasonography (CDUS) was performed to all the patients for the assessment of Resistive index (RI), Pulsatility index (PI), Peak systolic velocity (PSV) and End diastolic velocity (EDV) values of the operated kidney & the contralateral normal side. All examinations were performed by the same experienced radiologist and all ultrasound measurements were done by **B-K MEDICAL HAWK 2102 EXL system (See DOS Ltd, Analogic Corporation)** equipped with a 3.5-Mhz convex-array transducer. Similarly, postoperative CDUS measurements were done 24 h after ureteroscopy, and one month after the ureteroscopy. Calculation of the intrarenal RI, PI, PSV, and EDV values for each kidneys. In total, 60 kidneys were evaluated. When the central echo complex was separated minimally by distended anechoic calyceal structures, the kidneys were classified as hydronephrotic (grade 1). Non-dilated systems were categorized as grade 0 (absence of hydronephrosis). Patients with hydronephrotic kidneys greater than grade 1 were excluded from the study. Doppler signals were obtained from interlobar arteries along the edge of the medullary pyramids. Doppler spectral waveforms were optimized by using the lowest pulse repetition frequency possible without aliasing "introducing distortion", the greatest gain possible without background noise, a low-wall filter (50 Hz), and a 2 – 4 mm Doppler gate. Evaluation included obtaining waveforms in the upper, mid aspect, and lower pole of the kidneys. Multiple doppler waveforms were obtained from at least 3 – 5 vessels, and the values for each kidney were averaged. The angle correction cursor was adjusted parallel to the direction of flow and always $< 60^{O}$. This correction was performed in all spectral Doppler measurements. PSV, EDV, and mean flow velocity were measured directly. Measurement of RI and PI were performed with the use of online calculation software. RI was calculated as "(PSV-minimum diastolic velocity)/PSV" from the Doppler spectral waveforms using the built-in software of the sonographic equipment. An average RI was calculated from all the RI values from each kidney. Δ RI was calculated as the mean difference between the postoperative and preoperative RI values (postoperative - preoperative RI). PI was calculated as "(PSV - EDV)/mean velocity". An average PI was calculated from all the PI values from each kidney. Δ PI, Δ PSV, and Δ EDV were similarly calculated as the mean difference between the mean postoperative and preoperative values. In each patient, the mean RI, PI, PSV, and EDV for the contralateral normal kidney was also obtained and compared with the symptomatic side. The normal contralateral kidneys, which served as controls, were assessed according to same protocol. One month after the URS these measures were reassessed to be compared to their preoperative counterparts. Interventions were made under general anesthesia. The patients were positioned on the operating table in a lithotomy position with the leg stretched on the affected side and raised on the opposite side (Perez-Castro position).

Video monitoring and fluoroscopy were used in each case. Routine application of an endocamera was preferred to secure sterility and because of much easier manipulation. Warmed physiological saline solution was used as an irrigation fluid. After visualizing the ureteral orifice with cystourethroscopy, a guide wire was inserted through the orifice followed by rigid ureteroscopic evaluation with a 9.5 French ureteroscope. Operative time and volume of the irrigation fluid were recorded for each patient. Operative time was taken from the first entry of the ureteroscope into the ureter to the exit of the ureteroscope through the ureteral orifice. The amount of the irrigation fluid consumed during this time period was also recorded and regarded as "irrigation fluid volume". For statistical analyses, a commercially available software package (Statistical Package for Social Sciences, version 24.0, SPSS Inc., Chicago, IL, USA) was used. Categorical variables were summarized as numbers and percentages. Continuous variables were given as the means and standard deviations (median, minimum, and maximum, if required). Variables were compared using Student's t-test depending on the data type. For the comparison of postoperative and preoperative CDUS parameters (RI, PI, PSV, EDV, DRI, DPI, DPSV, and DEDV), paired samples t-test was used. Spearman correlation coefficient was obtained to investigate the correlation between continuous variables. Two-tailed P value of 0.05 was accepted as statistically significant.

3. Results

Clinical demographic data and renal morphological parameters in the study population were reported in (table 1). Mean renal parenchymal thickness, renal length, and width values for operated kidneys were comparable with the values for normal contralateral kidneys of which served as controls (P < 0.05).

Table (1): Clinical, demographic data, and renal morphological parameters in the study population.

Mean age (years)	36.2 ± 12.4 (16 – 57)
Gender (Male\Female)	8 \ 22
Side of ureteroscopy (Rt\Lt)	16 \ 14
Hydronephrosis in operated kidney (G0\G1)	13 \ 17 (43.3% \ 56.7%)
Mean operative time (min)	26.5 ± 12.258 (10 – 50)
Mean fluid volume (ml)	1595 ± 755.25 (500 – 3000)
Mean renal thickness	
Normal kidney (mm)	2.14 ± 0.34 (1.2 – 2.7)
Operated kidney (mm)	2.16 ± 0.39 (1.3 – 2.8)
Mean renal length	
Normal kidney (mm)	11.04 ± 0.58 (10 – 12.1)
Operated kidney (mm)	11.02 ± 0.54 (9.9 – 12.3)
Mean renal width	
Normal kidney (mm)	5.23 ± 0.75 (3.8 – 6.9)
Operated kidney (mm)	5.3 ± 0.52 (4.3 – 6.2)

Although, the P value was < 0.05, the mean RI increase on normal kidneys after ureteroscopies was only 0.03 (4.3% increase after the operation – Table 2).

Table (2): Comparison between Spectral Doppler analysis findings of normal kidney in preoperative day and one day postoperatively:

Parameters / Analysis	Preoperative Mean ± SD Median (range)	Postoperative day Mean ± SD Median (range)	P value*
RI	0.5283 ± 0.06018 0.53 (0.43-0.65)	0.5517 ± 0.06732 0.55 (0.43-0.69)	**0.001**
Δ RI	0.0233 ± 0.03188		
PI	0.8450 ± 0.15837 0.835 (0.60-1.17)	0.8860 ± 0.15253 0.88 (0.53-1.21)	**0.015**
Δ PI	0.0410 ± 0.08719		
PSV	33.6257 ± 5.99819 33 (24.6-45)	36.98 ± 9.65074 36.3 (25.6-77)	**0.017**
Δ PSV	3.3543 ± 7.25627		
EDV	15.7527 ± 3.31609 14.84 (11.1-23.4)	16.47 ± 4.18669 16.2 (8.7-28)	0.273
Δ EDV	0.7173 ± 3.519		

Significant P values were written as bold.

*Paired samples T test was used for preoperative and postoperative comparisons.

cm/s, centimeters/second, EDV, end-diastolic velocity; PI, pulsatility index; PSV, peak systolic velocity; RI, resistivity index; SD, standard deviation; Δ, mean difference between the postoperative and preoperative values (postoperative minus preoperative value for the relevant parameter).

However, for the operated kidneys, very significant statistical significances were noticed when RI (9% increase after the operation) and PI (13.5% increase after the operation) values were considered (P < 0.001)-(Table 3).

Table (3): Comparison between Spectral Doppler analysis findings of Operated kidney in preoperative day and one day postoperatively:

Parameters / Analysis	Preoperative Mean ± SD Median (range)	Postoperative day one Mean ± SD Median (range)	P value*
RI	0.6330 ± 0.06204 0.62 (0.52-0.75)	0.6950 ± 0.07977 0.69 (0.55-0.81)	**< 0.001**
Δ RI	0.0620 ± 0.03388		
PI	1.0230 ± 0.15844 1.0500 (0.70-1.37)	1.1690 ± 0.18301 1.20 (0.75-1.54)	**< 0.001**
ΔPI	0.1460 ± 0.10142		
PSV	31.7533 ± 6.6323 31.15 (20-43.4)	32.0653 ± 7.55781 29.8 (22.3-47.6)	0.793
ΔPSV	0.3120 ± 6.45568		
EDV	11.5867 ± 2.98972 10.7 (6.3-18.9)	9.9633 ± 3.71228 9.75 (4.6-19.8)	**0.007**
Δ EDV	-1.6233 ± 3.03255		

Significant P values were written as bold.
*Paired samples T test was used for preoperative and postoperative comparisons.
cm/s, centimeters/second, EDV, end-diastolic velocity; PI, pulsatility index; PSV, peak systolic velocity; RI, resistivity index; SD, standard deviation; Δ, mean difference between the postoperative and preoperative values (postoperative minus preoperative value for the relevant parameter).

The changes in mean RI (ΔRI) and PI (ΔPI) of the operated kidneys were also significantly greater than the changes of non-operated kidneys (P < 0.001). The differences in the mean ΔPSV and ΔEDV between the operated and non-operated kidneys were not statistically significant (Table 4).

Table (4): Comparison between the change of Doppler parameters in normal and operated kidneys on the first postoperative day

Groups / Parameters	Normal Kidney Mean ± SD	Operated Kidney Mean ± SD	P Value*
Δ RI	-0.02333 ± 0.03188	-0.062 ±0.03388	**< 0.001**
Δ PI	-0.04100 ± 0.08719	-0.146 ± 0.10142	**<0.001**
Δ PSV	-3.35433 ± 7.25627	-0.31200 ± 6.45568	**0.092**
Δ EDV	-0.71733 ± 3.51900	1.62333 ± 3.03255	0.2898

Significant P values were written as bold.
*Student's T test was used for the comparison of ΔRI, ΔPI, ΔPSV, and ΔEDV values.cm/s, centimeters/second, EDV, end-diastolic velocity; PI, pulsatility index; PSV, peak systolic velocity; RI, resistivity index; SD, standard deviation; Δ, mean difference between the postoperative and preoperative values (postoperative minus preoperative value for the relevant parameter).

The change in mean RI, which was represented in current study as ΔRI, was only correlated with the parameters; "operative time" and "irrigation fluid volume" (Table 5and 6). No significant relationship was documented between ΔRI and the other parameters; age, gender, side of ureteroscopy, stone location, and degree of hydronephrosis. On the other hand, none of the above parameters including operative time and irrigation fluid volume were correlated with ΔPI, ΔPSV, and ΔEDV values.

Table (5): Correlation of "Operative time" with mean ΔRI, ΔPI, ΔPSV, and ΔEDV values measured from the operated kidneys on the first postoperative day.

Variables	Parameters	Correlation coefficient	P Value*
Operative time	Δ RI	0.534	**0.002**
	Δ PI	0.386	**0.035**
	Δ PSV	-0.103	0.588
	Δ EDV	-0.284	0.128

Significant P values were written as bold.
*Spearman correlation coefficient analysis. EDV, end-diastolic velocity; PI, pulsatility index; PSV, peak systolic velocity; RI, resistivity index; SD, standard deviation; Δ, mean difference between the postoperative and preoperative values (postoperative minus preoperative value for the relevant parameter).

Table (6): Correlation of "Operative Fluid volume" with mean ΔRI, ΔPI, ΔPSV, and ΔEDV values measured from the operated kidneys on the first postoperative day.

Variables	Parameters	Correlation coefficient	P Value*
Operative Fluid Volume	Δ RI	0.390	**0.033**
	Δ PI	0.378	**0.040**
	Δ PSV	-0.15	0.939
	Δ EDV	-.155	0.412

Significant P values were written as bold. *Spearman correlation coefficient analysis.
EDV, end-diastolic velocity; PI, pulsatility index; PSV, peak systolic velocity; RI, resistivity index; SD, standard deviation; Δ, mean difference between the postoperative and preoperative values (postoperative minus preoperative value for the relevant parameter).

When the same parameters (RI, PI, PSV and EDV) are compared one month later after the ureteroscopies were performed with their counterparts on the preoperative day, it was found that Doppler findings of the normal kidneys were nearly the same with very negligible change whether in a positive or a negative pattern (Table 7). There was no significance in the correlation found between some parameters.

Table (7): Comparison between Spectral Doppler analysis findings of normal kidney in preoperative day and one month postoperatively.

Parameters / Analysis	Preoperative Mean ± SD Median (range)	One month Postoperative Mean ± SD Median (range)	P value
RI	0.5283 ± 0.06018 0.53 (0.43-0.65)	0.5247 ± 0.05412 0.51 (0.43-0.66)	0.602
Δ RI	-0.0037 ± 0.03810		
PI	0.8450 ± 0.15837 0.835 (0.60-1.17)	0.8287 ± 0.14619 0.84 (0.56-1.15)	0.416
Δ PI	-0.0163 ± 0.10833		
PSV	33.6257 ± 5.99819 33 (24.6-45)	36.878 ± 5.99935 36.8 (27-53)	**0.001**
Δ PSV	3.2523 ± 4.86311		
EDV	15.7527 ± 3.31609 14.84 (11.1-23.4)	17.4857 ± 3.29246 17.3 (12.1-24.3)	**0.006**
Δ EDV	1.7330 ± 3.18668		

Significant P values were written as bold.
*Paired samples T test was used for preoperative and one month postoperative comparisons.
cm/s, centimeters/second, EDV, end-diastolic velocity; PI, pulsatility index; PSV, peak systolic velocity; RI, resistivity index; SD, standard deviation; Δ, mean difference between the postoperative and preoperative values (postoperative minus preoperative value for the relevant parameter).

However, when Doppler analysis was performed on the operated kidney one month post ureteroscopies it was found that there was a significant reduction in the RI (5% decrease after one month) and the PI (8.9% decrease after one month) when these parameters were compared with their preoperative values (Table 8). It was also noted that the decrease in the values was not of a massive magnitude denoting that further follow up is required.

Table (8): Comparison between Doppler analysis of Operated kidney in preoperative day and one month postoperatively.

Parameters / Analysis	Preoperative Mean ± SD Median (range)	One month Postoperative Mean ± SD Median (range)	P value*
RI	0.6330 ± 0.06204 0.62 (0.52-0.75)	0.6023 ± 0.06694 0.60 (0.45-0.74)	**0.007**
Δ RI	-0.0307 ± 0.05771		
PI	1.0230 ± 0.15844 1.0500 (0.70-1.37)	0.9397 ± 0.13525 0.9150 (0.72-1.21)	**0.001**
ΔPI	-0.0833 ± 0.12904		
PSV	31.7533 ± 6.6323 31.15 (20-43.4)	36.8137 ± 5.30340 35.8 (28.5-50)	**0.003**
ΔPSV	5.0603 ± 8.56282		
EDV	11.5867 ± 2.98972 10.7 (6.3-18.9)	14.8203 ± 3.54729 14.75 (7.2-24.5)	**< 0.001**
Δ EDV	3.2337 ± 4.33552		

Significant P values were written as bold.
*Paired samples T test was used for preoperative and one month postoperative comparisons.cm/s, centimeters/second, EDV, end-diastolic velocity; PI, pulsatility index; PSV, peak systolic velocity; RI, resistivity index; SD, standard deviation; Δ, mean difference between the postoperative and preoperative values (postoperative minus preoperative value for the relevant parameter).

4. Discussion

As of late, the utilization of CDUS has demonstrated incredible significance in the evaluation of genitourinary disorders. This imaging procedure is non-intrusive, quickly performed, easy, and viewed as an economical strategy (Jha et al., 2016; Metzler et al., 2016). In spite of its restrictions in deciding practical importance of obstruction, gray scale US gives astounding anatomical data about 100% specificity for the detection of hydronephrosis(Brisbane et al., 2016).

Despite several undisputed advantages of Ultrasonography, barriers to implementation must be considered. Most importantly, the utility of US depends on the experience and skills of the operator, which are affected by the availability of training and the cost of ultrasound devices. Additional system barriers include availability of templates for documentation, electronic storage for image archiving, and policies and procedures for quality assurance and billing.(Bhagra et al., 2016).

As early in the course of obstruction, hydronephrosis may be absent or mild (grade 1), so functional evaluation of urinary tract during this period gains importance. For this purpose, scintigraphy has been used, but recently CDUS started to be used to obtain functional information(Nadzri et al. 2015).

The reason why we excluded cases with grade 2 hydronephrosis was mainly due to our aim to evaluate those patients within the gray zone. In addition, as RI may be increased with marked increases in hydronephrosis, by excluding those cases, false increases in RIs were prevented in the current study. To date, RI is one of the most sensitive parameters in the study of kidney diseases and allows us to quantify the changes in renal plasma flow. If a proper Doppler ultrasound examination is carried out and a critical analysis of the values obtained is performed, the RI measurement at the interlobar artery level has been suggested in the differential diagnosis between nephropathies.(Granata et al. 2014).

In an initialseries from researchers at the University ofMichigan, RIs from 21 hydronephrotic kidneys were obtained before nephrostomy. The mean RI in 14 kidneys with confirmed obstruction (0.77 + 0.04) was significantly higher than the mean RI from seven kidneys with non-obstructive pelvicaliectasis (0.64 + 0.04). Moreover, RI values returned to normal after nephrostomy. Later, the same authors published a study including 229 kidneys and proposed that the accuracy of the doppler diagnosis of obstruction increased when the RI of the potentially obstructed kidney was compared with that of the unaffected contralateral kidney(Tublin et al., 2003).

In our study, we evaluated the contralateral kidneys, which were accepted as controls. Mean renal volumes between operated and contralateral kidneys were also comparable. Shokeir et al. examined 22 pregnant women with acute unilateral ureteric obstruction and concluded that measurements of the difference between the RI of the corresponding and contralateral kidney was a sensitive and specific test that could replace intravenous urography(Shokeir et al., 2000). The same author found in a later study that Renal Doppler is a sensitive and highly specific test that can contribute significantly to the diagnosis of acute unilateral renal obstruction. It can replace the IVU, particularly in situations where IVU is undesirable. Also that the RI did not relate to the duration of renal colic or the level of ureteric obstruction.(Shokeir and Abdulmaaboud 2001).

More recently, a study revealed that the mean RI of obstructed kidneys was significantly greater than that of normal contralateral kidneys and concluded that CDUS could detect altered renal perfusion before pelvicaliceal system dilation start and distinguish obstructed cases(Onur et al., 2007).

In the early 1990s, several groups postulated that the pathophysiology of urinary obstruction might be reliably manifested by changes in arterial Doppler spectra. This application was based on exhaustive animal research that showed a unique biphasic hemodynamic response to complete ureteral obstruction. A short period (2 h) of likely prostaglandin-mediated vasodilation occurs immediately after obstruction. After this period, renal blood flow decreases, and renal vascular resistance increases. Introductory studies proposed that this vasoconstriction reaction was principally mechanical, because of increments in collecting system pressures. Recent research, however, suggests that complex interactions between several regulatory pathways (renin –angiotensin, kallikrein - kinin, and prostaglandin – thromboxane) are responsible for intense, postobstructive renal vasoconstriction. This vasoconstriction response, however mediated, seemed to be an ideal phenomenon to be detected by changes in the RI.(Tublin et al., 2003).

Similarly, the PI was also used as pulsed-wave Doppler measurement of downstream renal artery resistance. Both PI and RI values have been found to correlate with renal vascular resistance, filtration fraction and effective renal plasma flow(Cicoira et al., 2013).

In our study, besides RI measurement, we also preferred to evaluate PI, PSV and EDV values and investigated the changes on those parameters. However, only the changes in RI and PI values remained statistically significant between “operated kidney" and "normal kidney" groups. When we assessed the correlations with double group combinations, the operative time and irrigation fluid volume were only found to be correlated with ΔRI.

URS has become a definitive cornerstone in the diagnosis and treatment of ureteral obstructions. With advances in endoscopic technology and endourological techniques, URS has become less invasive and less traumatic. Most of the time, a 9.5 F ureteroscope is used for initial diagnosis (visualization of a ureteral lumen) and treatment (ureteral stone disease management via laser system) if necessary. The procedure was carried out with warmed saline solution either without or with ureteric dilation.(Liu et al., 2012) In our study, we used holmium laser for the elimination of stones in all managed cases.

During a URS operation, because of the irrigation fluid used, the irrigation pressures generated within the collecting system can be significantly elevated, and can even lead to pyelovenous and pyelolymphatic backflow. This backflow may create a pressure on the intrarenal vasculature and may also contribute to the increase in renal vascular resistance. In any way, the amount of the irrigation pressures transmitted to the renal pelvis, collecting ducts and subsequently to the parenchyma determines the degree of the vasoconstrictive response that would eventually lead to an increase in RI values.(Guzelburc et al., 2016).

Irrigation pressure is mainly affected by the amount of the irrigation fluid used, length of time period that the ureteroscope stayed within the ureter, irrigation fluid height from the patient and whether an irrigation pump is used or not. In our study population, since the height of the irrigation fluid was deliberately kept constant in all cases and the irrigation pump was not used on purpose in all the managed cases included in this study, main parameters involved in the etiology of this significant change were any prolongation of operative time and increase in the amount of irrigation fluid used.

So, during an URS operation, the urologist must be alert to the operative time and irrigation fluid consumed in order to prevent an increase in intrarenal vascular resistance (followed by a decrease in renal blood flow). Endourologists are already experienced in observing these two parameters during an operation, since their importance during a transurethral prostate resection operation are well documented. (Increase in these two parameters may cause transurethral resection syndrome which is a kind of dilutionalhyponatremia)(Alaali et al., 2015).

Re-evaluation of renal Doppler parameters one month after the URS was done yielded varying results in the normal and operated kidneys. Throughout the whole study, it was observed that RI in the normal kidney group nearly remained unchanged whether in the first postoperative day or on the day after one month from the procedure. This finding is quite rational given that there was no pathology or obstruction found and also there was no intervention needed.

However, findings were quite dissimilar regarding the operated kidneys. RI values that were obtained on the preoperative day were greater than those of the contralateral evaluated normal kidney. Also the values for the RI and the PI both were elevated after the URS operation was done (5% for the RI and 13.5% for the PI respectively).

On the third evaluation of Doppler parameters of the operated kidneys, values that were obtained were lesser than those of the postoperative day indicating that the effect of the URS operation on the renal vasculature are not of a permanent character. Also when comparing one month values to the preoperative parameters, it was found that RI decreased by 5% and that the PI decreased by 8.9% denoting that relive of obstruction lead to a decrease in the renal vascular resistance.

Potential limitations to this study should be considered. First of all, one could reasonably offer to form an independent control group which was composed of non-operated healthy subjects. However, we thought that it would be more homogenous and reliable to evaluate the normal contralateral kidneys of the operated patients since we only included cases with unilateral obstructed systems and excluded patients with abnormal-looking dilated contralateral kidneys. Secondly, our sample size does seem small but we hope prospective studies with larger series in near future may give more valuable data.

5. Conclusion

In conclusion, significant changes in RI and PI values in patients treated with URS revealed that URS operation itself can cause significant increase in renal vascular resistance that may eventually lead to a decrease in renal blood flow. With the increase in operative time and irrigation fluid volume used during the operation, renal vascular resistance (RI) seems to be significantly increased. However, vascular resistance returned to normal or even lower than normal after evaluation in one month duration indicating that vascular changes after URS operation are of a transient nature. Thus, it is thought that it would be better for an endourologist to manage URS operations with minimum operative time and that the volume of irrigation fluid infused must be as low as possible.

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