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Sonographic Comparison of Segmental Artery Resistive Index With Severity of Hydronephrosis

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Abstract

Background: Hydronephrosis is a major problem and colour doppler ultrasound is very useful to assess the hemodynamics of a diseased kidney, it is a therefore our research comprises sonographic analysis of segmental artery resistive index with the severity of hydronephrosis. **Materials and Methods:** This was a cross sectional analytical study carried out in Gilani Ultrasound center-Afro-Asian Institute, Lahore, Pakistan. Sixty patients of all ages were enrolled in this study with convenient sampling technique. A total of 60 individuals of all ages, both genders with calculus, masses, pregnant females, benign prostatic hyperplasia, (all the patients having hydronephrosis) were included in the study and individuals with Renal transplanted patients, nephrectomy, non-cooperative patients were excluded. The duration of the study was from December 2018 to October 2019. Toshiba (Xario 200) with convex transducer frequency range 2–5 MHz was used for this study. Age, gender, grade of hydronephrosis, pulsatility index and resistive index of segmental artery were the variables used in this study. Transabdominal scanning technique was used, Data were collected through data collection sheets and was tabulated and analyzed using Statistical Package for the Social Sciences (SPSS) version 24 (SPSS 24, IBM, Armonk, NY, United States of America), Microsoft Excel. **Results:** According to the results male patients with hydronephrosis (51%) were noted more than female hydronephrotic patients (48%). Mostly seen hydronephrosis grade in our study was mild (60%) while moderate hydronephrosis was (38.3) and severe was (1.7%). In our studies patients with left kidney hydronephrosis (56.7%) were more than that of right kidney hydronephrotic patients (43.3%). **CONCLUSION(S):** It is concluded that Doppler analysis is very helpful in the diagnosis of severity of hydronephrosis and to give detailed information about the pathophysiology of the hemodynamics of diseased kidney.

Keywords: Cross-Sectional Analytical Study, Pakistan, Hydronephrosis, Renal Stones, Ultrasonography

Introduction

Despite advances in medicine, hydronephrosis is a major problem. Obstruction results in increased pressure within the urinary tract, resulting in changes in morphology and physiology. The natural functioning of kidney comprises the elimination of end metabolic products and excessive quantity of water. In some cases because of

obstruction, the kidney becomes unable to do its work accurately resulting from this, the fluid resides within the kidney. The dilation or swelling of urine collecting system due to building up of urine is known as hydronephrosis. Moreover, the dilation of ureters due to the accumulation of urine is known as hydroureters.¹ During pregnancy, mostly prevalent pathology is the hydronephrosis. As stated by some writers in the third trimester, nearly 80 to 90 percent of females are affected by hydronephrosis. Patients with non-calculus hydronephrosis and hydroureter found that the most prevalent cause of hydronephrosis is pelvic ureteric junction obstruction, accounting for 38% of instances. The second most prevalent cause of benign prostatic hypertrophy is 22%, followed by vesicoureteral (16%), gravid uterus (8%) and retroperitoneal (6%). Other less known causes include urethral stenosis, neurogenic bladder, ureteric stenosis, and bladder outlet obstruction, which accounted for 2% of the remaining instances.² The main symptom of hydronephrosis is flank pain. Other symptoms include urinary pain, increased urge or frequency, inadequate urination, incontinence, nausea, and fever. These symptoms depend on the urinary blockage cause and severity.³ The Society of Fetal Urology (SFU) grading system classified hydronephrosis into five grades. Grade 0 = no hydronephrosis. Grade 1 = dilatation of renal pelvis only. Grade 2 = grade 1 + dilatation of few calyces. Grade 3 = grade 2 + dilatation of all calyces. Grade 4 = grade 3 + thinning of the renal parenchyma.⁴ Renal Doppler US offers useful hemodynamic data for multiple renal diseases, including blockage of the urinary tract, renal parenchymal disease, renal vascular disease, and kidney tumor. Ultrasound facilitates the non-invasive assessment of morphological alterations in the structure of the kidney (through B-Mode) and patterns of renal and extrarenal vascularization (through color-Doppler and enhanced contrast ultrasound). The renal resistive index was first shown to be a marker of the beginning and development of renal disease; later the effect of systemic vascular characteristics on the renal resistive index was shown and writers asserted its use as an essential predictor cardiovascular risk rather than of renal damage.⁵ According to a study conducted on Sonographic Evaluation of Hydronephrosis in 2015: "Renal ultrasonography has become the standard imaging modality in the investigation of kidneys because it offers excellent anatomic details, requires no special preparation of patients is readily available and does not expose the patient to radiation or contrast agents". Ultrasound is the best choice for the early investigation of the kidney. It is more sensitive to assess and classify the hydronephrosis and to determine its cause. One of the primary indications for referral to US evaluation of the kidneys is the evaluation of the urinary collecting system.⁶ Another study done in 2017 by PetritNuraj, NexhmiHyseni for diagnosis of Obstructive Hydronephrosis with Color Doppler Ultrasound resulted that ultrasound is a simple, non-invasive tool to use, and a fast way to support and diagnose obstructive hydronephrosis. Due to ultrasound's high sensitivity, it should be used as the first choice for screening method followed by other modalities, if important. Hydronephrosis is mostly seen in male patients with an average age of 55yrs. Urolithiasis is known to be the most common cause of kidney hydronephrosis of II degree. CT scan requires more time, money and exposes the patient to ionizing radiation. This last factor is of particular concern as renal calculi tend to recur and the mutagenic risks of radiation are cumulative in patients who undergo multiple studies.⁷ For checking the sensitivity and specificity of ultrasound for the diagnosing purpose of hydronephrosis, 125 patients having normal renal function went through ultrasonography (high-resolution real-time scanning) procedure after urography. The overall result in detecting hydronephrosis was 85.2%, sensitivity was recorded 89.9% and specificity of 84.4%. Based on this result ultrasound should be used for initial testing in case of hydronephrosis. However, if the ultrasound shows simple dilation of nephrons or ureters, urography is still required for the diagnosis of flank pain, type of obstruction, renal dysfunction.⁸ Study of RazaSayani in 2011 was conducted to identify the purpose of duplex Doppler ultrasonography (DDU) in patients under an acute unilateral renal obstruction. Pursued by intravenous urography (IVU) about 161 patients having urolithiasis were assessed by DDU. Among both kidneys of respective patient mean intra-arterial resistive index (RI) and the difference of mean resistive index were measured, according to the IVU, 51 patients have both normal kidneys and 110 patients have unilateral obstructive kidneys. The mean RI for obstructed kidneys was higher as compared to the mean RI of normal kidneys. The patients with normal kidneys have lower mean delta RI than those patients with unilateral ureteric obstructions respectively. The sensitivity of RI and delta RI were 77.5% and 92.5% with a specificity of 84.3% and 90.1% in patients with complete obstruction. In patients with partial obstruction sensitivity of RI and delta RI were 22.8% and 62.8% with a specificity of 84.3% and 90.1%. As a conventional imaging approach DDU cannot substitute IVU because of rather low sensitivity for the apprehension of partial obstruction.⁹ Renal Doppler US provides valuable hemodynamic information in various renal diseases including urinary tract obstruction, renal parenchymal disease, renal vascular disease, and renal tumor. The Doppler resistive index (RI) is a useful parameter for quantifying the alterations in renal blood flow that may occur with hydronephrosis. The intrarenal

resistive index is a physiological parameter that indirectly reflects the degree of resistance in the intrarenal vasculature. This research is therefore intended to know about the R.I of the renal segmental artery with the severity of hydronephrosis.

Materials and Methods

It was a cross sectional analytical study on Sonographic Comparison of Segmental Artery Resistive Index with the Severity of Hydronephrosis. Sixty patients of all ages were enrolled in this study with convenient sampling technique. The study was carried out in Gilani Ultrasound center-Afro-Asian Institute, Lahore, Pakistan. The duration of the study was from December 2018 to October 2019. Convenient sampling technique was used. The individuals of all ages, both genders with calculus, masses, pregnant females, benign prostatic hyperplasia, (all the patients having hydronephrosis). The individuals with Renal transplanted patients, nephrectomy, non-cooperative patients were excluded from the study. Toshiba (Xario 200) with convex transducer frequency range 2–5 MHz was used for this study. Age, gender, location of hydronephrosis, family history (positive or negative), grade of hydronephrosis, and resistive index of segmental artery were the variables used in this study. Transabdominal scanning technique was used, the patient lie in supine position for the evaluation of urinary bladder and ureters and right lateral decubitus position for the evaluation of left kidney and left lateral decubitus position for the evaluation of right kidney. If needed, ask the patient to inhale or exhale, which allows for subtle movement of the kidney. Liver was used as an acoustic window for the right kidney and spleen for the left kidney. Obtain longitudinal (long axis) and transverse (short axis) views. Patient's history was asked before the scan. If needed, you can have the patient inspire or exhale, which allows for subtle movement of the kidney. Ethical approval was gained prior from the Ethical Committee of the University before study All information and collected data were kept confidential. Participants were remained anonymous throughout the study. The patient was informed that there is no risk or any harmful effect on the procedure of study. They were also informed that they were free to withdraw at any time during the process. Procedure was properly explained, and consent was signed from the patient or patient's legal attendant. Data were collected through data collection sheets and was tabulated and analyzed using Statistical Package for the Social Sciences (SPSS) version 24 (SPSS 24, IBM, Armonk, NY, United States of America), Microsoft Excel.

Result

In this study, we enrolled 60 individuals, all of whom were diagnosed with hydronephrosis, 31 (51.7%) were male and 29 (48.3%) were female Table 1. The minimum age was 8 years out of 60 individuals and the maximum age was 90 years Table 4. More than the other grades of hydronephrosis, 36 (60%) patients had mild, 23 (38.3%) patients had moderate and 1 (1.7%) patient had severe hydronephrosis in 60 patients Table 2. 34 (56.7%) patients were presented with left kidney hydronephrosis and 26 (43.3%) patients were presented with right kidney hydronephrosis Table 3. The mean RI= 0.65 ± 0.102 with a range of 0.47 - 0.86 and the mean PI 1.15 ± 0.358 with a range of 0.66 - 2.22 Table 4. Of 29 female patients, 15 (1.7%) had mild hydronephrosis, 14 (48.3%) had moderate hydronephrosis, and no female patient had severe hydronephrosis Table 5. Out of 31 male patients 21 (67.7%) were with mild hydronephrosis, 9 (29.0%) were with moderate hydronephrosis and 1 (3.2%) was with severe hydronephrosis Table 5. Of 60 patients, 36 patients with mild hydronephrosis had a mean RI of 0.60 ± 0.086 , 23 patients with moderate hydronephrosis had a mean RI of 0.72 ± 0.83 , and 1 patient with severe hydronephrosis had a mean RI of 0.78 ± 0 Table 6.

Table 1: Gender

	Frequency	Percent
Valid Female	29	48.3
Male	31	51.7
Total	60	100.0

Table 2: Grade of hydronephrosis

		Frequency	Percent
Valid	Mild	36	60.0
	Mode	23	38.3
	Severe	1	1.7
	Total	60	100.0

Table 3: Right/Left kidney

		Frequency	Percent
Valid	Lt	34	56.7
	Rt	26	43.3
	Total	60	100.0

Table 4: Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
age	60	82.00	8.00	90.00	39.8333	19.48939
Resistive Index (RI)	60	.39	.47	.86	.6515	.10226
Pulsatility Index (PI):	60	1.56	.66	2.22	1.1510	.35822
Valid N (listwise)	60					

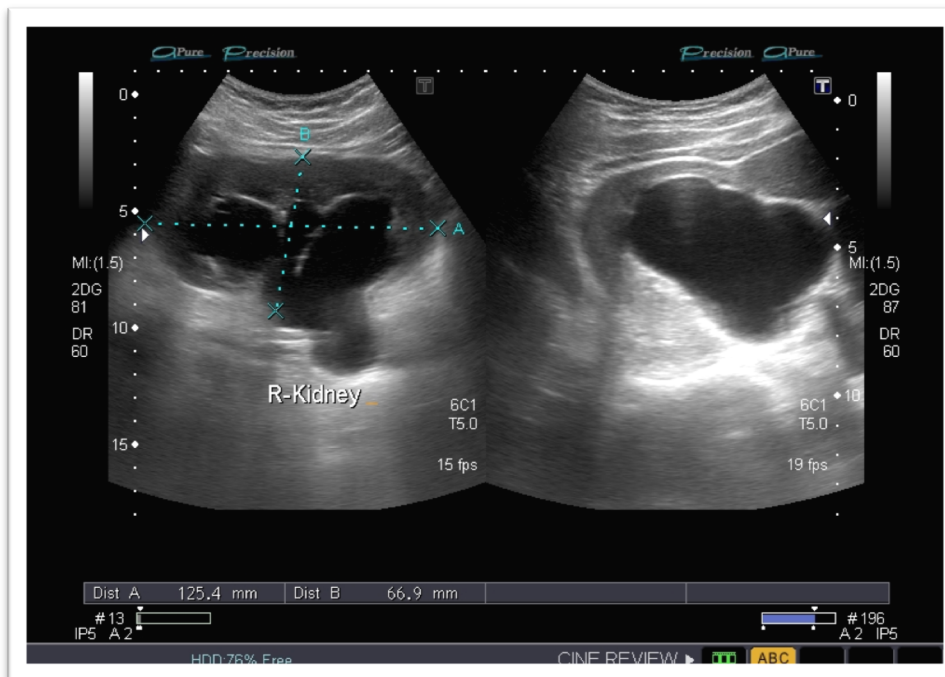
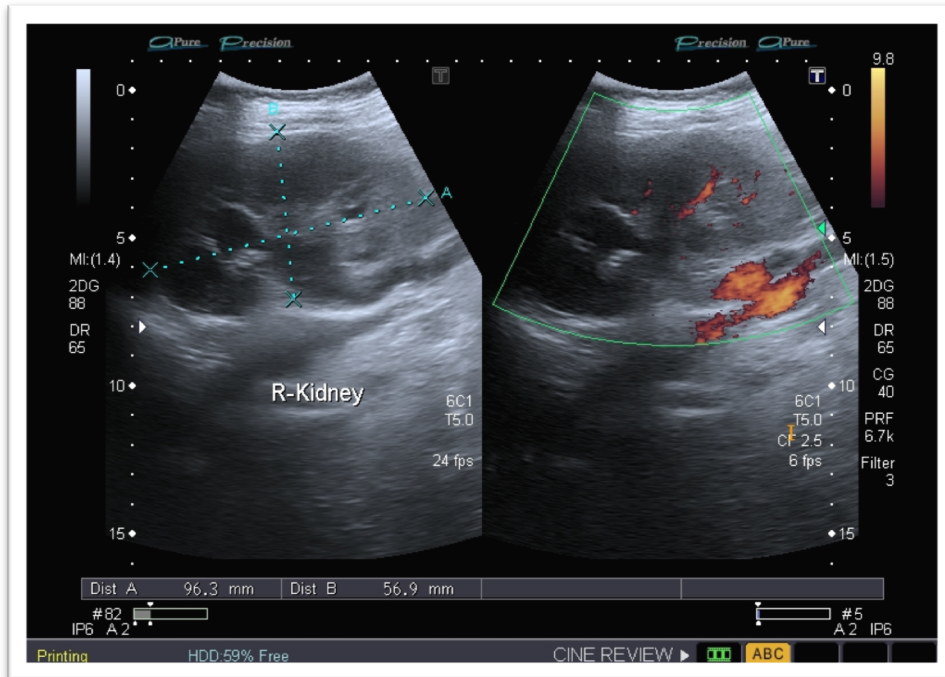
Table 5: Gender * Grade of hydronephrosis: Crosstabulation

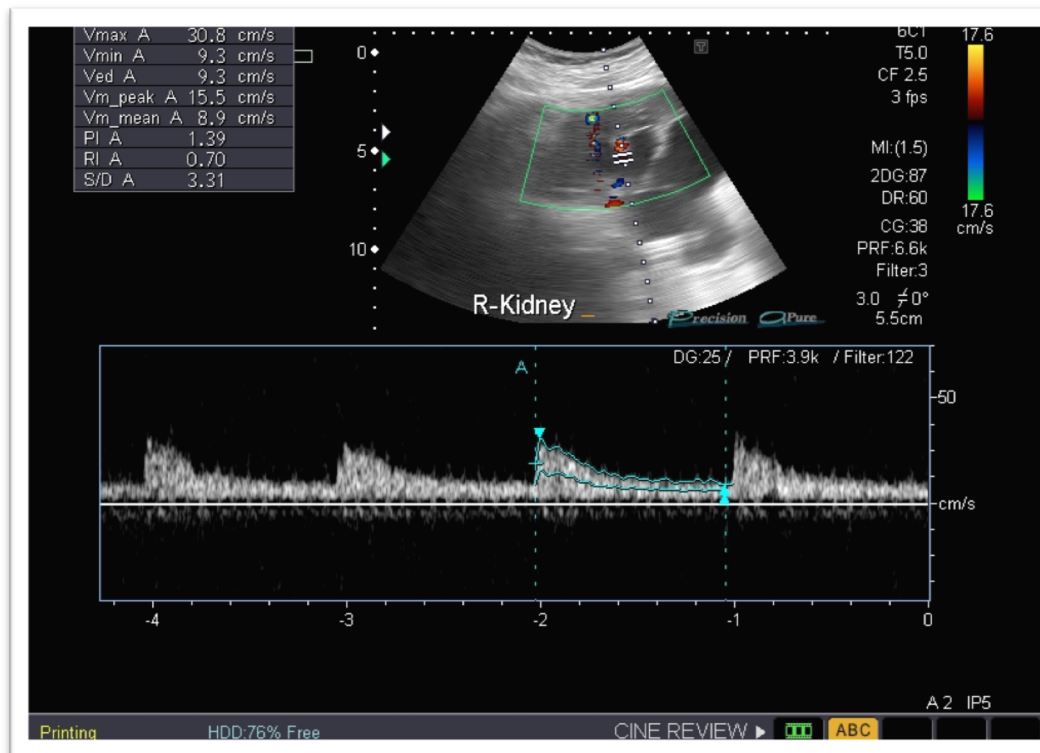
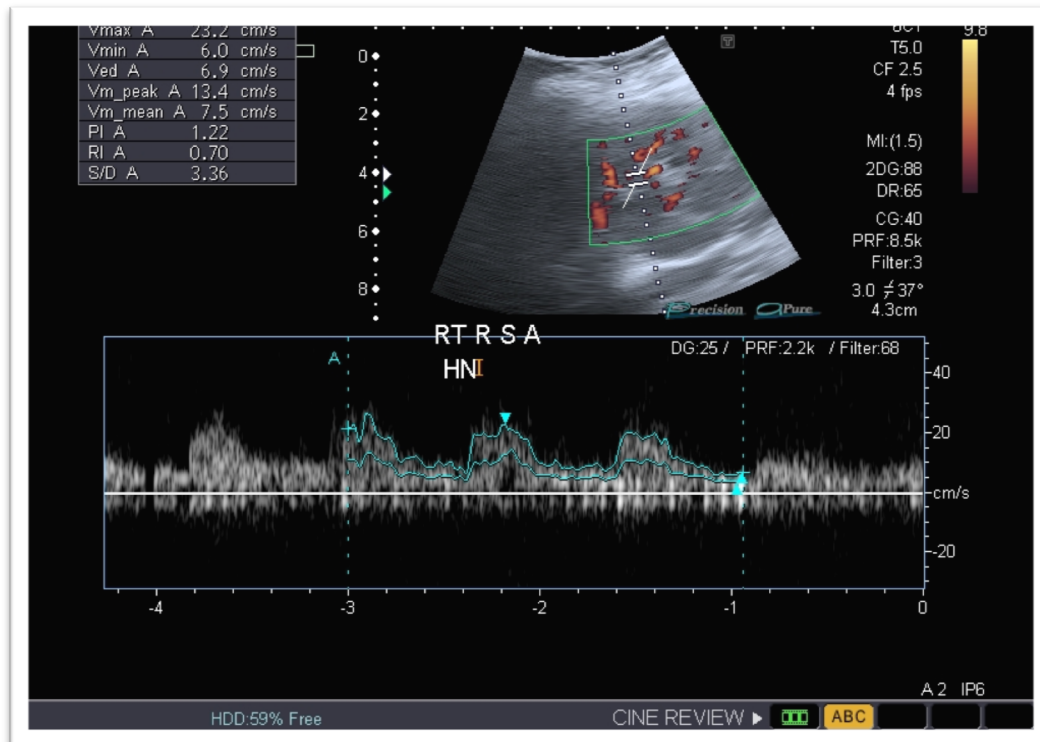
			Grade of hydronephrosis:			Total
			Mild	Mode	Severe	
gender	Female	Count	15	14	0	29
		% within gender	51.7%	48.3%	.0%	100.0%
	Male	Count	21	9	1	31
		% within gender	67.7%	29.0%	3.2%	100.0%
Total		Count	36	23	1	60
		% within gender	60.0%	38.3%	1.7%	100.0%

Table 6: Report

Resistive Index (RI)

Grade of hydronephrosis:	Mean	N	Std. Deviation
Mild	.6042	36	.08650
Mode	.7200	23	.08257
Severe	.7800	1	
Total	.6515	60	.10226





Discussion

We started our research on the topic of Sonographic Comparison of Segmental Artery Resistive Index with The Severity of Hydronephrosis because hydronephrosis is very common due to the blockage of urinary tract system and is a cause of flank pain. The cause of hydronephrosis is obstruction in urinary system. Obstruction can occur at the renal pelvic-ureteric junction due to many reasons some of them are mass, benign prostate hyperplasia, pregnancy, stone, etc. Several studies were performed on hydronephrosis. Urolithiasis formation is a common problem and is very common if a patient have a family history of it.¹⁰ Obstruction due to stone is most common.

In a research done by Atar and his fellows, kidney stone prevalence was 8.8%. The prevalence of stone in men was 10.6% relative to 7.1% in women. Kidney stones were more common in overweight than normal-weight individuals (11.2% versus 6.1% , respectively; $p < 0.001$). Obesity and diabetes were closely linked with the history of kidney stones.¹¹ In another study calcium containing stone were reported most common. The male to female ratio was 2.4:1. An increased tendency of stone formation was noted in middle aged patients (40-47y).¹² In study by Sultan Abdulwadoud Alshoabi, Ultrasound reports of 210 patients with hydronephrosis were included. Males account for around 67.14% of the sample (67.14% vs. 32.86%). Unilateral hydronephrosis was found in most patients (91.8 percent). The right kidney was more affected than the left (52.7% vs. 41.4%). The sample showed hydronephrosis in grade 2 (58.57%), grade 3 (20%), grade 1 (12.38%) and grade 4 (9.1%) of patients respectively.¹³ According to the study of Afshar Zomorodi, Four factors might play a part in the development of stones within the lower pole of the kidney. Of these, the IPA and infundibulum diameter were more prevalent in the left kidney; therefore, the left kidney could be more engaged in stone disease.¹⁴ Ultrasound imaging is a form of imaging that is non-invasive, low priced and widely available. It can obtain precise medical assessment without radiations in most scenarios of acute and chronic renal obstruction. However, it is a commonly accepted, a very helpful and highly accurate to diagnose hydronephrosis but it is not very effective to determine the cause of obstruction.¹⁵ A study was done to evaluate the importance of Doppler resistive index (RI) ultrasound sampling in distinguishing non-obstructive and obstructive hydronephrosis in kids. Kidney Doppler evaluations of intra-renal renal arteries were conducted on 16 kids (19 kidneys) with maternal hydronephrosis from August 2011 to November 2012. The autonomous t-test was used to evaluate the important difference in RI outcomes between those with obstructive hydronephrosis (6 kidneys) and non-obstructive hydronephrosis (13 kidneys) as calculated by dynamic kidney scintigraphy. The evaluator was screened to the outcomes of the clinical findings and scintigraphy. Between obstructive and non-obstructive hydronephrosis, RI was considerably distinct. Higher RI values were transferred by obstructive hydronephrosis, with a mean RI of 0.78. Mean RI in non-obstructive hydronephrosis was 0.70, and the difference was significant ($p < 0.05$). The sensitivity and specificity of Doppler ultrasound were 100% and 53% respectively. Doppler ultrasound measurement of the resistive index is useful in differentiating obstructive from nonobstructive hydronephrosis and provides an alternative non-ionizing investigation.¹⁶ Piazzese EM, Mazzeo GI researched on 14 October 2012. The objective of this study was to determine whether the renal resistive index (RI) can predict hydronephrosis in patients with renal colic (RC) and whether or not its performance is time-dependent. The study population was composed of 54 patients admitted for unilateral RC. At the time of the first observation, each patient underwent routine examinations, abdominal ultrasonography, and renal color Doppler ultrasound (CDUS) with measurement of the RI. Each patient underwent non-contrast urinary tract CT 48-60 h after admission. A mean renal RI of > 0.70 (mRI+) for the symptomatic kidney was considered indicative of obstruction. A mRI+ on CDUS predicted the onset of hydronephrosis with 100% sensitivity, 84% specificity, 92.6% accuracy, PPV and NPV of 87.9% and 100%, and diagnostic efficiency of 84%.¹⁷ In our study male patients with hydronephrosis were noted more (51%) than female hydronephrotic patients (48%). Mostly seen hydronephrosis grade in our study was mild (60%) while moderate hydronephrosis was (38.3) and severe was (1.7%). Age is not related to hydronephrosis as we enrolled patients of all ages.

Clinical significance:

The performed study was clinically significant. Moreover, from the research, it is concluded that segmental artery resistive index can be used as an important tool in sonography for the detection of diseased renal vascular hemodynamics.

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Conflicts of interest:

There are no conflicts of interest

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