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„Renal hemodynamics in patients with acute obstructive uropathy evaluated by duplex Doppler study

ABSTRACT

Objective: To detect the sensitivity of Doppler study of renal arterial resistivity index in patients with acute obstructive uropathy presented by hydronephrosis and hydroureter by taking CT-KUB study.

Methods: this is a comparative cross-sectional prospective analysis done between January 2020 and march 2021. The data were collected in Rizgary teaching hospital. The study included patients with flank pain referred to Radiology department and those with hydronephrosis included in the study. Same number of normal participants were examined by ultrasound for comparison. The ultrasound examination undertook between 2-6 hours after the onset of loin pain.

Results: the data was collected from 51 patients, age ranging from 18-57 years, and equal number of participants of relatively the same age was collected, males constitute about 78.4% of total number of 51 patients, females constitute of about 19.6%.
Hydronephrosis has been found in all patients with loin pain; divided into three categories; mild (72.5%), moderate (27.5%), no sever hydronephrosis was recorded in the study.
The stone was confirmed by ultrasound in 20 patients constituted about 39.2%, the stone in 31 patients was confirmed by CT-KUB which constituted 60.8%.
Resistive index of affected kidney was 0.689, in contrast the resistive index of the contralateral normal kidney was 0.613.

Conclusion: Doppler ultrasound with measurement of RI is effective in the evaluation of distal ureteric obstruction, but it cannot replace the CT-KUB. Hence, this study concludes that the renal resistivity indices should not be interpreted in isolation.

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Introduction:

The intra-renal resistive index is a physiological framework that indirectly reflects the degree of resistance in the intra-renal vasculature.

Resistive index measurements have been promoted for the diagnostic evaluation of various renal pathologies, including acute obstructive uropathy [1].

Renal colic is a common issue, affecting roughly 2-3% of the population at some point of their lives [2]. Early and accurate diagnosis are necessary to reduce the catastrophic effects of obstruction on urinary tract structures and function [3].

Plain abdominal radiograph has very low sensitivity for the observation of urolithiasis [4]. Small calculi are generally obscured by overlying bowel gases or fecal particles. Furthermore ribs, transverse process and sacrum may obscure calculi [4]. US is usually used to diagnose the acute renal colic, but unlikely it fails to demonstrate hydronephrosis in acute obstruction of the kidney in 50% of cases [3]. US has sensitivity of 37% for ureteral calculi [5], therefore, CT-scan has become the main radiological study for assessment of urolithiasis and is used as the gold standard for urolithiasis [6], CT-scan has sensitivity of about 95% and specificity of 98% [7].

As a consequence of high cost, radiation dose and high work-load of CT [8], US must be altered to increase its diagnostic effectiveness to reveal acute obstructive uropathy and Doppler US can be used to control this difficulty. Renal arterial resistive index is most commonly used among doppler indices [9]. Doppler study can non-invasively supply convenient information about renal hemodynamics and build diagnosis of acute obstructive uropathy more precisely. When collecting system is acutely obstructed the pressure of renal calyces increases with changes in renal blood flow resulting in elevated resistive index [10].

The RI sensitivity reported in literature 75.5% and specificity of 92.5% for acute obstruction [11].

While patients with acute flank pain commonly have been examined with

conventional radiography or intravenous urography, non-enhanced CT lately has become the cornerstone foe screening of urolithiasis, prior to acceptance of CT, US was considered as a low-risk, low-cost alternative to intravenous urography, and it was shown have a reasonable sensitivity and specificity for depiction of calculi and acute obstruction [12].

Renal arteries

In most individuals, each kidney is supplied by a single artery that originates from abdominal aorta. The renal arteries typically arise from the aorta at the level of L2 vertebral body below the origin of the superior mesenteric artery, with the renal vein being anterior to the renal artery. The arteries course anterior to renal pelvis before they enter the medial aspect of the renal hilum. The right renal artery typically demonstrates a long downward course to the relatively inferior right kidney, traversing behind inferior vena cava. Conversely the, the left renal artery, which arises below the right renal artery and has a more horizontal orientation, has a rather direct upward course to the superiorly positioned left kidney. Both renal arteries usually course in a slightly posterior direction because of the position of the kidneys [14].

The main renal artery divides into segmental arteries near the renal hilum. The first division is typically the posterior branch, which arises just before the renal hilum and passes posterior to the renal pelvis to supply a large portion of the blood flow to the posterior portion of the kidney. The main renal artery then continues before dividing into four anterior branches at the renal hilum: apical, upper, middle and lower anterior segmental arteries. The apical and lower anterior segmental arteries supply the anterior and posterior surfaces of the upper and lower renal poles respectively; the upper and middle segmental arteries supply the remainder of anterior surface. The segmental arteries then course through the renal sinus and branch into the lobar arteries. Further

divisions include the interlobar, arcuate, and interlobular arteries. Depiction of the relatively avascular plain between the anterior and posterior arterial divisions of the kidney is important to the surgeon, because the site can be used for a clean incision toward the renal pelvis at time of surgery [14]. The site is usually located posteriorly, one third of the distance between the posterior and anterior kidney surface. A similar avascular plain exists between the posterior renal segment and the polar renal segments [15].

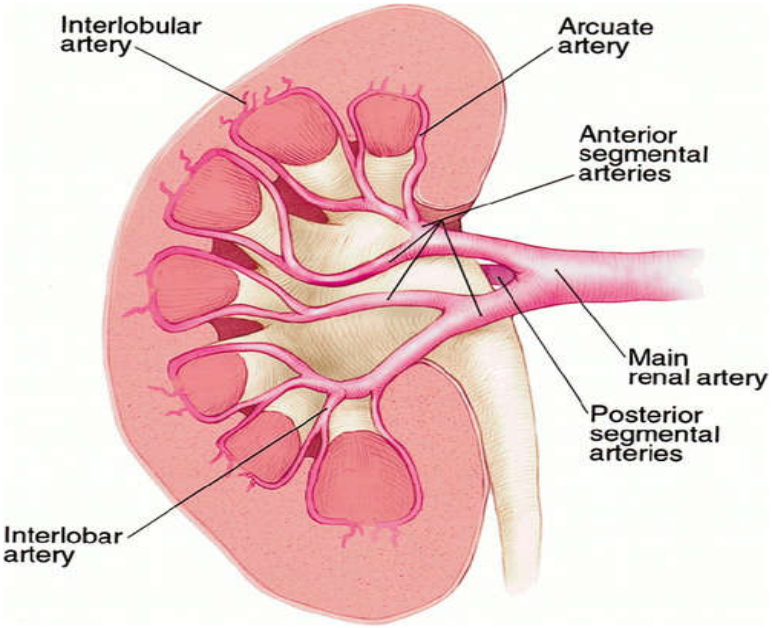

Figure (2) demonstrates the normal anatomy of the renal artery [15].

What does mean RI (Resistive Index):

RI (resistive index) is explained:(peak systolic velocity- end diastolic velocity)/peak systolic velocity.

The use of RI in acute obstructive uropathy is relying on physiological features that a reduction in renal blood flow and an elevation in renal vascular resistance are the signs of remarkable acute obstruction. Platt *et al* recently noticed that ureteral obstruction with hydronephrosis made changes in doppler waveform, whereby an increase in downstream resistance resulted in a more marked reduction in diastolic blood flow compared to the systolic component [13].

Materials and methods:

The study was approved by the ethical committee of Kurdistan Board of Medical Specialties. The study is comparative cross sectional prospective design done between January 2020 and march 2021. The data were collected in Rizgary Teaching Hospital. The study included patient who suffered from loin pain referred to radiology department and those with hydronephrosis included in the study. Equal number of normal participants were examined by ultrasound for comparison. A total of 51 patients who complained of flank pain and 51 participants with ages between 18-57 years were included in the study. Ultrasound was done for each kidney of patients and of normal participants with 3.5 MHz convex probe and those with hydronephrosis have been recorded in the case sheet and those in which the cause of acute obstruction has not been revealed by ultrasound, CT-KUB was done. Inclusion criteria are all adult patients complaining of ureteral colic suspected of having ureteric stone and referred to the ultrasound unit in Rizgary teaching hospital who have definite ureteric stone detected either by ultrasound or by CT-KUB. Exclusion criteria: 1) Patients older than 60 years, because of atherosclerosis may alter the RI result. 2) Patients younger than 18 years, because CT radiation risks. 3) Patients have single kidney or transplanted kidney. 4) Patients with chronic medical diseases like diabetes mellites and hypertension.

The data were entered to SPSS data as a raw information, the relation between obstruction and resistive index have been analyzed.

Results:

A total of 102 participants enrolled in this current study, equally divided into cases (51) and case control (51), 41 subjects in each group was male and only 10 participants were female. The mean age of study sample in general was 34.46 ± 9.85 years (figure 1). The cases and controls were matched for age and sex.

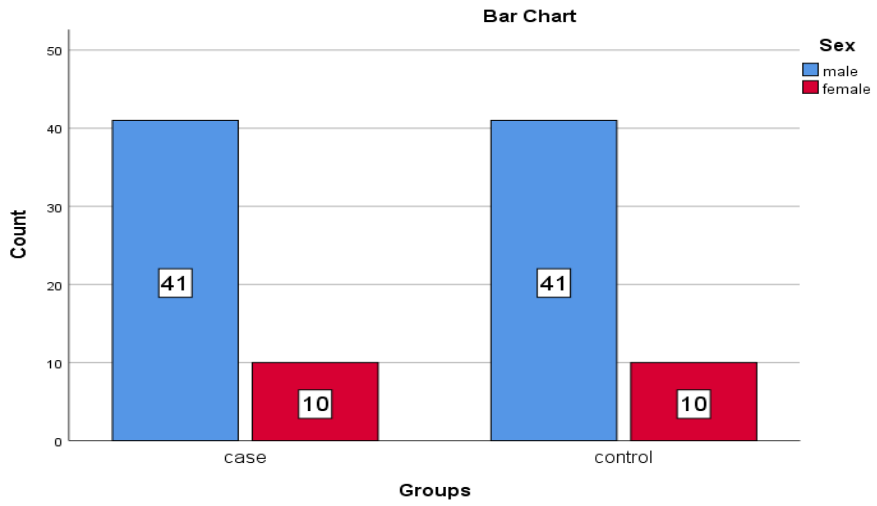

Figure 1: Gender distribution of cases and control group.

Table 1 reveals that most (60.8%) of cases had right loin pain, while (39.2%) of patients presented with left loin pain, most (72.5%) of them had mild hydronephrosis followed by only 27.5% of them having moderate degree hydronephrosis, no sever hydronephrosis were recorded in the study.

Table 1: Clinical Features and hydronephrosis of the cases.

Variables	Categories	Frequency	Percent
Clinical Features	right loin pain	31	60.8%
	left loin pain	20	39.2%
Hydronephrosis	mild	37	72.5%
	moderate	14	27.5%
Side of hydronephrosis	right	31	60.8%
	left	20	39.2%
	Total	51	100

The result of table 2 shows that there was a statical significant difference between resistive index of affected kidney and resistive index of contralateral or normal kidney of the same patient, the average of affected kidney had a resistive index of 0.689 ±0.031, in contrast the resistive index of the contralateral kidney was lower (0.613 ±0.024), t-test was done and it was highly significant with p-value less than (0.001).

Table 2: Resistive index of affected and contra-lateral kidneys among cases.

Resistive index	Mean	N	Std. Deviation	p-value	t-test
RI of affected kidney	0.689	51	0.031	< 0.001	significant
RI of contralateral kidney	0.613	51	0.024		

Table 3 reveals that there was a statically significant difference in resistive index between cases in comparison with controls, the mean resistive index for cases was 0.689 ±0.031 while the average resistive index for control group was 0.611 ±0.010, t-test was used to compare between the means, it was significant and p-value was less than 0.001.

Table 3: Comparison between cases and control group regarding their resistive index.

Groups	N	Mean	Std. Deviation	p-value	t-test
case	51	0.689	0.031	< 0.001	significant
control	51	0.611	0.010		

Discussion:

Without dilatation, a rise in intraluminal pelvi-ureteric pressure occurs at first. Following that, a hemodynamic response to altered perfusion as a result of increased vascular resistance occurs. Hydronephrosis develops if the obstruction is not removed.

Despite the fact that sonography is commonly used to demonstrate collecting system dilatation due to obstruction, numerous papers have reported the limitations of sonography (a) in the time between obstruction and onset of dilatation, and (b) in the inability to detect obstruction when dilatation is not possible due to the nature of the pathological process affecting the kidney, and (c) in the separation of dilated non-obstructed and dilated obstructed kidneys (Amis et al,

1982; Maillet et al, 1986; Naidich et al, 1986; Lalli, 1977; Lyons et al, 1988).

Thus, except when direct pressure measurements have been obtained during invasive interventional procedures (percutaneous nephrostomy, etc.), the diagnosis of acute renal obstruction has rested on the IVU and the manifestation of these hemo- and urodynamic responses as a dense persistent nephogram with delayed excretion of contrast medium into the affected pelvicalyceal system. The availability of duplex Doppler study now raises the possibility of expanding the role of sonography in acute renal obstruction by allowing direct assessment of these hemodynamic responses. As the renal vascular resistance rises in response to obstruction, the predominant change in the doppler waveform is a drop in the diastolic flow. This most simply measured and expressed as the RI. This development may allow ultrasonographic recognition of acute ureteric obstruction in the absence of dilatation.

Recent work has documented significant elevation in the intrarenal resistance index in established renal obstruction, distinguishing between dilated obstructed and dilated non-obstructed kidneys and suggesting discriminatory RI of 0.7 between the obstructed and normal kidneys studied (plat et al, 1989 a, b).

Our study first aimed to examine a group of normal individuals to establish a range of normal RI values and, secondly, to see if the RI changes could be demonstrated in renal colic at presentation.

A total of 102 participants enrolled in this current study equally divided into 51 cases (patients) and 51 controls (participants). The mean age of patients is 36.08 years while of participants is 32.7 years. 41 (80.39%) patients were males and only 10 (19.61%) patients were females, the same number of males and females were included in participants.

Of the patients; 37 (72.5%) had mild hydronephrosis and 14 (27.5%) with moderate hydronephrosis. None of the

patients in this study showed severe hydronephrosis or absence of hydronephrosis. This is in contrast to the study of Platt JF et al. The contrast in our study might be due to fluids administered prior to sonography and the degree of obstruction caused by the calculus.

In the present study, the mean resistive index (RI) of the obstructed kidney was 0.689 and that of contralateral non-obstructed kidney was 0.613. Both of these values are within the normal limit of 0.7 but the difference appears to be statistically significant with p-value 0.001. Only 27.4% of the patients with obstruction showed elevation of RI above 0.7. The study of Platt JF et al had revealed that the mean RI value of 0.77 in obstructed kidneys. They have included both acute and chronic cases of obstruction and also coexisting renal disease. Their results indicated that obstruction is not the only renal abnormality that can elevate the RI, as over half of the patients with non-dilated renal disease had RI greater than or equal to 0.7. The probable reason for reduced mean RI in our study might be that only 27.4% of the patients with obstruction showed elevation of RI above 0.7.

Conclusion: The renal resistivity indices thus are less sensitive in diagnosing acute ureteric obstruction. This is due to varying degrees of obstruction and pyelosinus extravasation. However, indices within the normal range did not rule out obstruction. Hence, this study concludes that the renal resistivity indices should not be interpreted in isolation.

References:

1. Scales Jr CD, Curtis LH, Norris RD, Springhart WP, Sur RL, Schulman KA, Preminger GM. Changing gender prevalence of stone disease. The Journal of urology. 2007 Mar 1;177(3):979-82.
2. Sommer FG (1993) Sonographic evaluation of renal colic. KidneyCurr Surv World Lit 2:129.
3. Haroun A. Duplex Doppler sonography in patients with acute renal colic: prospective study and literature review. Int Urol Nephrol 2003; 35: 135-40.

4. ottlieb RH, La TC, Erturk EN, Sotack JL, Voci SL, Holloway RG, et al. CT in detecting urinary tract calculi: influence on patient imaging and clinical outcomes. Radiology 2002; 225: 441-9.
5. Tamm EP, Silverman PM, Shuman WP. Evaluation of the patient with flank pain and possible ureteral calculus. Radiology 2003; 228: 319-29.
6. Sharma A. Unenhanced helical CT in renal colic. Internet J Radiol 2005; 4. doi: 10.5580/ebf.
7. Rucker CM, Menias CO, Bhalla S. Mimics of renal colic: alternative diagnoses at unenhanced helical CT. Radiographics 2004; 24 (Suppl 1): S11-S28.
8. Patlas M, Farkas A, Fisher D, Zaghal I, Hadas-Halpern I. Ultrasound vs CT for the detection of ureteric stones in patients with renal colic. Br J Radiol 2001; 74: 901-4.
9. Kim SH. The usefulness of pulsatile flow detection in measuring resistive index in renal doppler US. Korean J Radiol 2002; 3: 45-8.
10. Tseng FF, Bih LI, Tsai SJ, Huang YH, Wu YT, Chen YZ. Application of renal Doppler sonography in the diagnosis of obstructive uropathy in patients with spinal cord injury. Arch Phys Med Rehabil 2004 ; 85: 1509-12.
11. Geavlete P , Georgescu D, Cauni V, Nita G. Value of duplex doppler ultrasonography in renal colic. Eur Urol 2002; 41: 71-8.
12. Douglas H. Sheafor, Barbara S. Hertzberg, Kelly S. Freed ,et al. Nonenhanced Helical CT and US in the Emergency Evaluation of Patients with Renal Colic: Prospective Comparison. Radiology 2000;217:292-797.
13. Shokeir AA, Provoost AP, Nijman RJ. Resistive index in obstructive uropathy. British journal of urology. 1997 Aug;80(2):195-200.
14. El-Galley RES, Keane TE. Embryology, anatomy, and surgical applications of the kidney and ureter. Surg Clin North Am 2000; 80:381–401.
15. Urban BA, Ratner LE, Fishman EK. Three-dimensional volume-rendered CT angiography of the renal arteries and veins: normal anatomy, variants, and clinical applications. Radiographics. 2001 Mar;21(2):373-86.