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Intrarenal Arterial Doppler Evaluation in Acute Ureteric Obstruction

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Abstract
Objective: *To determine the diagnostic utility of intrarenal arterial Doppler study in ureteric obstruction. To compare intrarenal arterial doppler in patients with obstructed and non obstructed kidneys.*
Materials & Methods: *Study included prospective inclusion of 63 patients presenting within 24 hrs of the onset of symptoms of unilateral acute renal colic. The case group included kidney with the obstruction side and the opposite side healthy kidney considered as the control. All patients underwent USG and Doppler scan using 2-5 MHz convex probe and will be assessed for the presence or absence of pelvicalyceal system dilatation on the gray-scale images. Minimum three Doppler spectra will be obtained from interlobar arteries along the border of the medullary pyramids, and their mean RI calculated. RI of 0.70 remains the upper limit of average intrarenal resistance. CT scan will be done if ultrasonography is equivocal. If the site of obstruction is up to or proximal to L3 vertebral level, it is considered as proximal obstruction and distal if it is beyond L3 vertebral level.*
Results: *Resistivity Index (RI) in segmental renal arteries of all the 63patients was significantly higher in the obstructed kidney than in unobstructed kidney (0.7 vs 0.56; p<0.001) with a sensitivity of 87.3% and specificity of 90%.*
Conclusions: *Doppler ultrasound is a useful diagnostic tool in the diagnosis of acute ureteric obstruction, thus preventing unnecessary CT and minimizing radiation exposure to patients. RI value > 0.7 have a very high level of specificity and sensitivity for acute ureteric obstruction.*
Keywords: *Intrarenal arterial Doppler; Acute renal colic; Acute ureteric obstruction; RI value.*

Introduction

One of the common presenting complaints in the emergency department is acute renal colic.USG is the first line of investigation, which can identify the presence and cause of obstruction with a sensitivity of 77.5%.[1] Arterial RI measurements by duplex Doppler USG have been advocated for the diagnosis of obstruction.[2] To improve the diagnostic sensitivity and specificity of USG in suspected acute unilateral renal obstruction, Doppler may be used as an adjuvant tool as it can demonstrate changes in renal blood flow and renal pelvic pressure changes.[3]

Material and Methods

Study Design: Prospective case-controlled study.
Study Duration: 12 months (December 2018 to November 2018)
Study Sample: 63 patients, Male: 40, Female 23.
Inclusion Criteria
All patients with symptoms of acute renal obstruction presenting to the emergency

department of our Institution within 24 hours of the onset of unilateral acute renal colic were part of this study.

Exclusion Criteria

Patients with a history of Renal parenchymal disease, Patients on Dialysis ,Chronic renal obstruction, Bilateral renal obstruction,Renal trauma, Diagnosed cases of renal artery stenosis & Renal vein thrombosis, Acute renal insufficiency, Patients with a Single kidney, Congenital anomaly of the kidneys.

Methodology

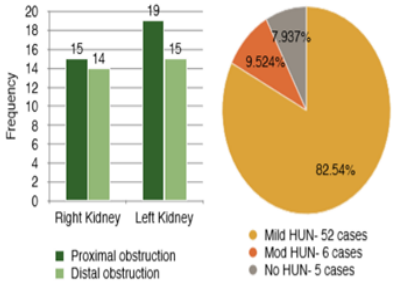
All subjects of the study population underwent USG and Doppler evaluation in Philips Affiniti-70/ HD7 XE machines using C 1-5 MHz transducer and presence or absence of pelvicalyceal system dilatation was assessed in each kidney. CT was done for those patients in whom US could not confirm the cause of obstruction, which has the sensitivity of 95% and specificity of 98%.[4] Those patients with no obstruction by CT were excluded from the study. The kidney on the obstructed side was treated as the case kidney, and the contralateral healthy (unobstructed) kidney served as the control. Minimum three Doppler spectra were obtained from inter-lobar arteries along the border of the medullary pyramids, and their mean RI was taken. 2-5mm Doppler sample width will be set. Mean renal arterial RI value will be calculated for both kidneys. The formula for calculation of renal artery RI is RI= (peak systolic velocity – end diastolic velocity)/peak systolic velocity. The difference in RI of the corresponding and contralateral kidney will determine the Delta RI. RI of 0.70 remains the upper limit of average intrarenal resistance. Ultrasonography will be used to confirm pelvicalyceal dilatation. CT scan will be done if ultrasonography is equivocal. If the site of obstruction is up to or proximal to L3 vertebral level, it is considered as proximal obstruction and distal if it is beyond L3 vertebral levels.

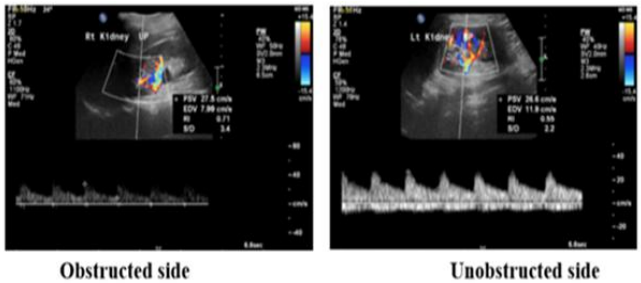
Statistical Analysis: All data were collected systematically, tabulated and analyzed using Microsoft Excel and Strata 6 for Windows. Student t-test was used in univariate analysis for continuous variables, and the Chi-square test was used for the study of noncontiguous data. A p-value of less than 0.05 was considered to be statistically significant.

Results

The mean Resistivity Index (RI) in obstructed kidneys was significantly higher than in unobstructed kidneys (0.75 vs 0.56; $p < 0.001$). The differences in RI between obstructed and unobstructed kidneys (Delta RI) ranged from 0.09 to 0.38 with a mean Delta RI of 0.24. This study showed a sensitivity of 87.3% and specificity of 90% for detecting acute unilateral renal obstruction with a cut off RI of 0.7. The distal obstruction showed more RI value than proximal obstruction, and it was statistically not significant. (0.79 vs 0.76; p=0.09).

	Frequency	Mean RI	Standard Deviation	Mean RI >0.7	Mean RI <0.7
Obstructed	63	0.75	0.08	57 (90.5%)	6 (9.5%)
Unobstructed	63	0.56	0.09	8 (12.5%)	55 (87.3%)





Obstructed side Unobstructed side

KIDNEY	RI +/- SD
Obstructed kidney	0.75 +/- 0.08
Unobstructed kidney	0.56 +/- 0.09
Delta RI	0.24 +/- 0.08

Discussion

Aneela Azam et al. conducted a similar study on 75 patients taking a RI value of >0.70 as reference obtained similar results with increased sensitivity of 76.23% and specificity of 88.13%[5]

Piazzese et al. had conducted a study on 54 renal colic patients to determine whether renal RI changes were time-dependent by recording doppler values at 6,12,18,24,36 and 48 hours and concluded that statistically significant mean RI values were recorded within 24 hrs symptoms which are supportive of the results obtained in this study[6].

Sonali S Saboo et al. got Mean delta RI of 0.08 in their study conducted on 43 patients which is statistically non significant. But results on threshold RI, PPV & NPV are similar to this study.

Conventional gray scale USG has been shown to be sensitive (90%) but not specific (65%-84%) in the diagnosis of renal obstruction[7]. Ultrasound may miss ureteric obstruction in a small proportion of patients in whom an obstructed pelvicalyceal system is not dilated[8] These conditions include[9]:

1. Low diuresis resulting from dehydration,
2. Underlying renal parenchymal disease
3. Intermittent obstruction by calculus
4. Decompression of the PCS through a tear of a calyceal fornix.

Pelvicalcyeal dilatation may be missed if the PCS system is filled with the blood clot, calculus, tumour or pus and some times, mild dilatation may be overlooked[1]. Taking RI >0.7 as an indirect sign of acute unilateral renal obstruction reduces the probability of misdiagnosis in such conditions.

Discussion - Rationale behind RI

Normal flow within the renal artery and its branches have a "low resistance" perfusion pattern, with continuous forward blood flow during diastole. Acute unilateral ureteric obstruction results in a complex sequence of changes in renal blood flow and ureteric pressure[10]. IN < 2hrs: In a short period immediately after the obstruction (<2hour) prostaglandin mediated vasodilatation occurs. IN 2-6 hrs: After this period, renal blood flow decreases and renal vascular resistance increases due to complex interactions between several regulatory pathways like renin-angiotensin, kallikrein-kinin & prostaglandin- thromboxane. In 6-18 hrs: Renal blood flow remains reduced, because of vasoconstriction of the afferent arterioles and the ureteric pressure decreases. Previous studies have shown that the increase in RI occurred after as little as six hours of clinical obstruction[11]. However, presenting to the hospital in the first five hours after the onset of renal colic is uncommon[12]. Obtaining a normal RI in the presence of significant obstruction is mainly due to technical error[13]. The correct scale (pulse-repetition frequency) usage is recommended to expand the waveform size to fill as much of the available display as possible, without aliasing, is crucial[14].

Conclusion

Doppler added with conventional grey scale USG is a promising new diagnostic method in detection of acute renal obstruction if presented within 24hrs of onset of symptoms, especially when there is an absence of collecting system dilatation. RI measurement has increased the sensitivity and specificity of conventional USG in diagnosing acute ureteric obstruction and helps to avoid unnecessary ionizing radiation with CT KUB.

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