

Comparison of Resistivity Index of Segmental Arteries Between Normal and Obstructed Kidneys in Ureterolithiasis with Doppler Ultrasonography

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Abstract:

These days, the most common problem that the urologists face is Urolithiasis and renal colic is the most highlighted one. Renal obstruction due to urolithiasis is the most frequent cause. This disease is widespread in our country and 12% of the Pakistani population has urolithiasis.

Objective:

To compare the resistivity index of segmental arteries between normal and obstructed kidneys in ureterolithiasis with Doppler Ultrasonography.

Methods:

Comparative analytic study was conducted. 115 patients were selected through simple random sampling technique. Fifty-five patients were presented with ureterolithiasis and sixty (60) normal individuals in nine months duration in the Radiology department of University of Lahore and Gilani ultrasound center. All the patients went through gray-scale and Doppler ultrasonography to evaluate the Doppler index value of segmental artery.

Results:

Out of 115, 55 were suffering with ureterolithiasis and 60 were normal. 5.2% of the cases were found with >0.70 resistivity index (RI) and 4.3% with the upper limit. 90.4 % cases were below the upper limit of RI. The mean RI value of the obstructed right cases was 0.65 ± 0.08 and in normal right kidneys 0.54 ± 0.07 . The mean resistive index value of the obstructed left cases was 0.63 ± 0.05 and in normal left kidneys 0.54 ± 0.08 and the resistivity index comparison between the obstructed right and obstructed left kidneys was 0.65 ± 0.08 vs 0.63 ± 0.05 .

Conclusions:

It is concluded that ureteric stones were capable of elevating the RI of segmental arteries. The number of cases found with elevated RI were 5.2% and 4.3% with the upper limit. Although the percentage of cases

having elevated RI was small but results were significant.

Keywords:

Urolithiasis, Doppler Ultrasonography, segmental arteries, hydronephrosis, resistive index.

Introduction:

Renal obstruction due to urolithiasis is the most frequent cause.¹ Clogging of the urinary system is a condition in which the flow of urine is blocked or is not properly drained. This causes the urine to backup and affect the kidneys. When there is a resistance in urine drainage through the kidneys, ureter or bladder it's called obstructive uropathy. It can occur suddenly or become long-term. Urine back flows into the kidney and causes it to become swollen and bloated. This condition is called 'hydronephrosis'. The most common cause of obstructed uropathy is urolithiasis (formation of stony concretions in urinary tract).² About 80% of patients with kidney stones are males. Males mostly go through this experience between 30 and 40 years of their age, while women experience this at later age. Numerous studies have shown that males are more prone to kidney stones than females. Renal obstruction due to urolithiasis is the most commonly found cause. It is widespread in our country and 12% of the Pakistani population has urolithiasis.³ Grayscale ultrasound can detect dilation of the urinary tract near the site of obstruction, which is an indirect proof for diagnosis. It is sometimes not possible to differ between acute and chronic obstruction with gray scale ultrasound alone. Nor does it reveal the dilatation of the collection system in almost 35% cases of acute obstruction. Doppler ultrasonography delivers more beneficial information in cases of urinary tract obstruction. There is a reduction in the volume of the renal vessels due to the pressure developed in collecting system at acute stage of renal obstruction.

This results in increased vascular resistance.⁴ In a previous study by Middleton WD *et al*, in 1998, the sensitivity of kidney stones to ultrasound was 96%, which was more reliable than abdominal radiography and somewhat lower than abdominal radiography and renal tomography. The results of the study showed that the ultrasound gray scale is an effective way for the detection of kidney stones in patients with suspected nephrolithiasis.⁵ Doppler ultrasonography can provide noninvasive information on renal hemodynamics and make the diagnosis of obstructive uropathy more reliable. When the collector system is acutely clogged, the pressure within the kidney calyces increases with changes in renal blood flow resulting in an increase in RI (RI > 0.7). According to a report the sensitivity of the resistivity index was 75.5% and the specificity was 92.5%.⁵ According to Gealvete P *et al* ultrasound can replace the IVP test Sensitive and very specific.⁶ The intrarenal duplex Doppler ultrasound is capable of providing useful physiological information regarding the state of resistance in renal vascular system. Researchers suggests that 0.70 is as a reasonable upper limit for the normal value of intrarenal resistivity index. Therefore, Doppler imaging appears to be a useful technique in the evaluation of the dilated or almost clogged kidney. In addition, intrarenal Doppler ultrasound may be a beneficial noninvasive test to suggest the importance of incomplete obstruction. Non-obstructive renal insufficiency may also cause an increase in the resistivity index.⁷

The aim of my study was that, does the resistivity index value of an obstructed kidney by ureteric calculus elevates from the upper-limit or not? After comparing and diagnosing the changes in resistive index of both cases and controls it is seen clearly that there is a significant difference in resistive index. This aim was fulfilled and the above publications clearly justified this debate and my study.

Methods:

A comparative analytical study with a sample size of 115 patients, 55 patients of obstruction by ureteric calculus and 60 normal was conducted based on an objective to compare the changes in resistive index of the segmental arteries in obstructed kidneys by ureteric calculus and in normal kidneys. The study was carried out at the Radiology Department of The

University of Lahore and Gilani ultrasound center Lahore from Feb 2015-Oct 2015. The machines used for data collection were Mindray UMT-300 and Xario XG Toshiba with transabdominal (3.5-5MHz) probe. All patients (both male and female) who came with the complaint of renal colic and urinary stones were included. Every patient went through grey-scale ultrasound along with Doppler ultrasonography and were scanned out by transabdominal scan by oblique approach to get a better access to the kidneys. Variables taken were resistivity index, size of calculus in the ureters, hydronephrosis and position of calculus. Data collection analysis was carried out by using statistical package for social sciences (SPSS version 20.0).

Results:

Out of 115, 55 were suffering with ureterolithiasis and 60 were normal as shown in table 1. The minimum and maximum age in right obstructed kidneys was 12-65 years with a mean value of 33.69 ± 8.3 . Whereas, the minimum and maximum ages in normal right kidneys was 16-60 years with a mean value of 30 ± 11.3 . The mean RI value of the obstructed right cases was 0.65 ± 0.08 and in normal right kidneys 0.54 ± 0.07 . The mean RI difference of obstructed and normal right kidneys was 0.1021 with a significant p-value (0.00).

Kidney	N	Age	Mean age	Mean resistive index	Std. Deviation	Mean resistive index difference	p-value
Obstructed right	26	12-65	33.69 ± 8.3	0.6508	0.08251	0.1021	0.00
Normal right	60	16-60	30 ± 11.3	0.5487	0.07029		

Table1: Mean resistivity Index of segmental artery of obstructed and normal right kidneys

Table 2 showed that the minimum and maximum ages in obstructed left kidneys was 22-60 years with a mean age 36 ± 10.26 and 16-60 years with a mean age 30 ± 8.3 years in normal left kidneys. The mean RI value of the obstructed left cases was 0.63 ± 0.05 and in normal left kidneys 0.54 ± 0.08 . The mean RI difference of obstructed and normal left kidneys was -0.0897 with a significant p-value (0.00).

Kidney	N	Age	Mean age	Mean resistive index	Std. Deviation	Mean resistive index difference	p-value
Normal left	60	16-60	30±8.3	0.5475	0.08382	-0.0897	0.00
Obstructed left	29	22-60	36±10.26	0.6372	0.05437		

Table 2: Mean resistive Index of segmental artery of obstructed and normal left kidneys

Out of 55, 26 cases of the right kidneys had ureteric calculi and 29 cases were in the left kidneys, as shown in Table 3. The mean RI value of obstructed right kidneys is 0.65 ± 0.08 and 0.63 ± 0.05 in the obstructed left kidneys.

Kidney	N	Mean RI	SD
Right obstructed	26	0.6508	0.08251
Left obstructed	29	0.6372	0.05437
Total	55	0.6436	0.06878

Table 3: Mean resistivity index of obstructed right and obstructed left kidneys

According to table 4, 11(20%) of the calculi were present in the upper ureter, 11(20%) in mid, 9(16.4%) in lower, 2(3.6%) in right uretero-pelvic junction (R-upj), 10(18.2%) in right uretero-vesical junction (R-uvj) and 12(21.8%) in left uretero-vesical junction (L-uvj). Out of 55, 30 cases had mild hydronephrosis and 25 with moderate level of hydronephrosis. No cases were found with severe degree of hydronephrosis.

Position of Calculus	Frequency	Percent	Valid Percent	Cumulative Percent
Upper ureter	11	20	20	20
Mid ureter	11	20	20	40
Lower ureter	9	16.4	16.4	56.4
Right uretero-pelvic junction	2	3.6	3.6	60
Right uretero-vesical junction	10	18.2	18.2	78.2
Left uretero-vesical junction	12	21.8	21.8	100
Total	55	100	100	

Table 4: Position of calculus in obstructed right and left ureters
According to table 5, 5.2% of the cases were found with >0.70 RI and 4.3% with the upper limit. 90.4 % cases were below the upper limit of RI.

RI	Frequency	Percent
>0.70	104	90.4
<0.70	6	5.2
0.7	5	4.3
Total	115	100

Table 5: Percentage of RI groups in normal and obstructed kidneys

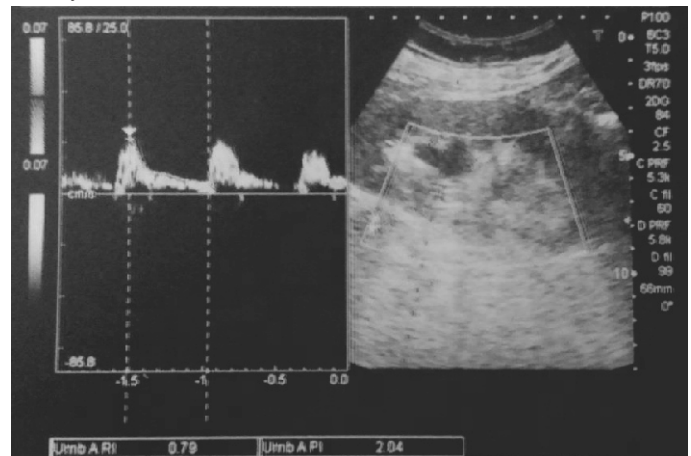


Figure 1: 60 years male with mild hydronephrosis in left mid ureter, calculus size 5.4mm, RI 0.79

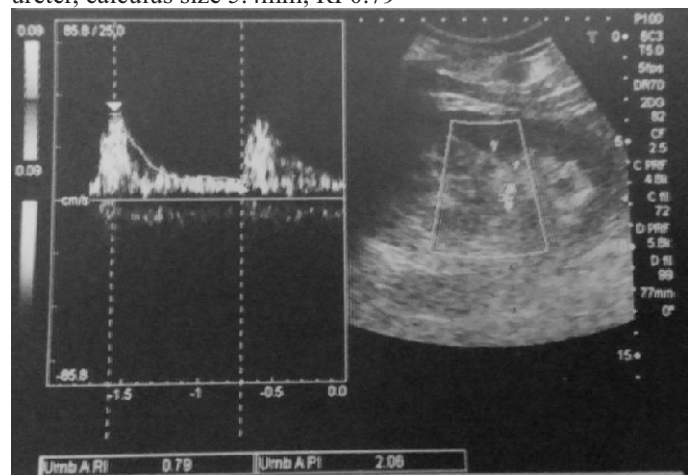


Figure 2: 65 years old female with moderate hydronephrosis in left upper ureter, calculus size 11.3mm, RI 0.79

Discussion:

Greyscale ultrasonography alone is not a reliable modality in diagnosing the renal obstruction so Doppler U/S can provide more beneficial information regarding obstruction and Platt JF in 1992, Webb JA in 2000, Platt JF *et al*, in 1989, Piazzese EM *et al*, in 1992 and Platt JF *et al*, in 1993 supported this statement.^{7,8,9,10,11} Various studies had targeted the interlobular arteries and arcuate arteries for measuring the

resistive index but this study was done on the segmental arteries. Hyder RR *et al*, in 2009, conducted a case control study on Pakistani population to promote the usefulness of inter-renal resistivity index difference in diagnosing acute unilateral ureteric obstruction due to calculus. The mean RI of cases was 0.69 compared to 0.58-0.59 in controls.¹² In Italy, Bertolotto M *et al*, in 1999 reported the changes in resistivity index in normal subjects and in patients with silent obstructing and non-obstructing stones. According to their study the RI of normal subjects was 0.62 ± 0.03 (considered as within normal range) but the mean resistive index value of obstructed kidneys was significantly higher than the upper limit 0.73 ± 0.02 with a p-value (<0.01). Study supported the debate that the changes in RI value between normal and obstructing kidneys can be significant which makes Doppler ultrasonography a promising diagnostic tool.¹³ In 2014 at University of Babylon, Jassim SM *et al*, conducted a study to assess ureteric stones by measuring the resistive index of renal vessels. The study included 131 patients, 71(54.2%) with ureteric calculus and normal contralateral kidneys. The mean resistive index of obstructed cases was 0.72 ± 0.03 and in controls 0.63 ± 0.02 . A significant difference was seen with a p-value <0.05 .¹⁴ Saboo SS *et al*, also agreed to these significant results.¹⁵ In our study, RI comparison between of obstructed right and normal right kidneys was 0.65 ± 0.08 vs 0.54 ± 0.07 and 0.63 ± 0.05 vs. 0.54 ± 0.08 of the obstructed left and normal left kidneys. The mean resistive index of the obstructed right kidneys was higher than the obstructed left kidneys (0.65 ± 0.08 vs 0.63 ± 0.05) and the resistive index of both right and left kidneys were significantly higher than their contralateral normal kidneys. This showed that the mean RI value of both cases and controls showed variable results which significantly supports the objective of this study. Platt JF, considered 0.70 is considered as a reasonable upper-limit of intrarenal hemodynamics.⁷ Rodgers PM *et al*, found an increased resistivity index in acutely obstructed kidneys, especially when compared with the resistive index in normal contralateral kidneys and with a control group of healthy subjects.¹⁶ Similar results were obtained by Platt JF *et al*, in patients with acute unilateral obstruction by ureterolithiasis.⁹ Every patients went through greyscale and Doppler

ultrasonography and ultrasound was found likely to be a reliable modality in detecting the ureteric stones. Patlas M *et al*, have claimed that ultrasound is a reliable and efficient source of detecting ureteric stones.¹⁷ In 2009, Elgamasy A and Elsherif A conducted a study in literature which supported the results of my study.¹⁸

Conclusions:

The number of cases found with elevated RI were 10% and 9% with the upper limit. Although the percentage of cases having elevated RI was small but results are significant. It was concluded that ureteric stones are capable of elevating the resistive index of segmental arteries. The results showed that the size of calculus did not have much of a significance in elevating RI but the position of calculus showed noticeable results.

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