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Doppler Comparison of Resistive Index of Renal Artery in Obstructive and Non Obstructive Kidneys

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Abstract
Background: Renal obstruction evaluation by X-Rays and CT scan is harmful and causes ionization in the body. That's why we find out the Diagnostic Accuracy of Doppler Ultrasound by doing it in our population for the Accurate and Early Detection of RI, especially in Renal obstruction. Objectives: To compare the resistive index of the renal artery in obstructive and non-obstructive kidneys by Doppler ultrasound. Methods: Comparative study design was used for this study. 162 patients are taken as sample size from different hospitals (DHQ Joharabad and Gillani Center, Lahore). The duration of the study was 3 Months after the approval of synopsis. Sampling technique used was Convenient Sampling technique. Date collected with the help of questioner and analyzed by using SPSS 22 mean, standard deviation, frequency distribution, and t-test. Results: The mean score value of the resistive index in non-obstructive kidney group was 0.63 ± 0.02. The minimum score value was 0.60, and the maximum score value was 0.66. In obstructive kidney group, the mean value of the resistive index was 0.77 ± 0.03. The minimum score value was 0.73, and the maximum score value was 0.81. There is a significant difference between these two groups as the p value of the t test statistics is less than the level of significance. Conclusion: It was concluded that calculi obstructive kidney caused prominent changes in the value of the resistivity index as compared to the resistivity index of normal kidney. The effect of obstruction has caused elevation of resistivity index pattern.

Keywords: Intra-Obstructive Kidney, Non-Obstructive Kidney, Resistive Index

Introduction

Doppler ultrasonography has proved to be a useful tool in differentiation of obstructive and non-obstructive kidneys. Severe renal obstruction causes a decrease in blood flow and an increase in resistance (Platt et al. 1989; Kojima et al. 2000). Doppler and conventional ultrasounds are helpful in the diagnosis of kidney obstruction in patients with flank pain (Rodgers, Bates & Irving 1992). With the use of resistive index, the changes in the intra-renal arteries of obstructive kidney patients can be quantified. Resistive Index can be measured as PSV-EDV/PSV ([Peak Systolic Velocity-End Diastolic Velocity]/Peak Systolic Velocity). Doppler ultrasound also provides information about the arterial blood flow and urinary flow in obstructive kidney patients (Azam, Arfan & Beg 2013; Aziz et al. 2005). The mean value of renal artery in hilar region is more (0.6±0.17) when compared with arteries of small distal and in arteries of inter-lobar, the minimum value is (0.54±0.20).
The evaluation of the resistive index in intra-renal arteries is necessary in nephrological problems like renal hypertension and advance renal damage leading to renal failure. The normal value of RI is 0.70, and is used to differentiate the resistive index in the renal artery of obstructive and non-obstructive kidneys (Bloch & Basile 2003). The increase in RI above 0.70 shows obstruction (ed. Strandness 2000).

The pathophysiological changes in the flow of blood in renal obstruction may easily be checked by the Doppler parameters that is called resistive index. The value of RI after obstruction 6 hours increases and its peak retain for 6-48 hours with minimum changes (Ellenbogen et al. 1978). Significant or complete obstruction of urinary tract increase the resistive index that is not formed in non-obstructive dilation hence imaging by Doppler useful in obstructed kidney evaluation of dilated. In addition, intra-renal Doppler Sonography may prove to be a useful non-invasive test to suggest the significance of partial obstruction. Non-obstructive renal disease can also cause elevation of the resistive index (Basturk et al. 2012a). Non-obstructive kidneys have low RI values than obstructive kidneys (Tublin, Bude & Platt 2003).

Urolithiasis is one of the most common disorders of the urinary tract. Kidney stone prevalence is estimated to be 3% in all individuals, and it affects up to 12% of the population during their lifetime. Currently, mortality from stone disease is rare, although there is still a significant rate (28%) of renal deterioration with certain stone types. Renal obstruction due to urolithiasis is the most frequent cause. This disease is prevalent in our country, and 12% of the Pakistani population has urolithiasis (Azam, Arfan & Beg 2013). The choice of therapeutic alternative depends on the factors including calculi dimension and localization, uretheral dynamics, presence of obstruction, and associated urinary infection. When the obstruction is present in the upper urinary tract, it induces modifications in intra-renal blood flow compared to systolic one. The modification is revealed by resistive index determination on duplex Doppler ultrasonography (Shokeir et al. 1996a; Shokeir et al. 1996b).

Doppler ultrasonography is advantageous because it is a non-invasive procedure, and there is no exposure of radiation or iodinated contrast agents. This method is highly specific and sensitive. The sensitivity of Doppler ultrasound is round about 90% (Basturk et al. 2012b; Bellos, Perrea & Kontzoglou 2019; Beloncle et al. 2019). The rationale of the study is to study the accuracy of renal Doppler ultrasonography in our population. If we find high accuracy of ultrasound in the future, then we can measure the resistive index of obstructive renal diseases, especially in those areas where CT scan and x-rays are not available.

Methods

The design of our study was comparative and conducted at DHQ Joharabad and Gillani Center, Lahore. By convenient sampling technique, the required information was collected. The total sample size of our study was 162. The inclusion criteria for patients of our study were patients with renal stones, ureteric stricture, ureteric stone, UVJ obstruction, and hydronephrosis. Similarly, the exclusion criteria for patients of our study were as patients having renal cysts, renal cell carcinoma, and pregnant female.

The ultrasound machines of Toshiba Xario 100 with Convex transducer with a 3-5 MHz frequency was used. All ethical considerations for this study were fulfilled according to needs. Data collected on a sheet of data collection after informed by a written consent form. According to gender, age variables data was collected. History/complaints/clinical diagnosis was taken from the participants. All variables were asked directly from individuals. Data were analyzed by using SPSS, and data also tabulated. Descriptive statistics were calculated for data. For quantitative data, the mean and standard deviation was used for qualitative variables frequency distribution was used to describe data.

Results

The main objective of our study was to compare the RI (resistive index) value of renal artery in non-obstructive and obstructive kidney with Doppler ultrasound. This study was conducted to evaluate the significance of Doppler ultrasound for patients which have not the facility of CT scan and which avoid the rays. In obstructive kidneys group, the mean age of the patients was 41.42 ± 11.85 years. The minimum age value was in obstructive
kidney group was 20, and the maximum age value was 60 years. Similarly, in non-obstructive kidney group, the mean values of age were 39.10 ± 12.06 years. The minimum age value was in non-obstructive kidney group was 20, and the maximum age value was 60 years. Age is an important variable for any study, especially related to medical studies.

In obstructive kidneys group, the mean value of the patients for history was 4.86 ± 1.85 years. The minimum value for history in obstructive kidney group was 2, and the maximum value was 8 years. Similarly, in non-obstructive kidney group, the mean value of history was 4.85 ± 4.85. The minimum history value was in non-obstructive kidney group was 2, and the maximum history value was 8 years. History is an important variable for any study specially related to medical studies.

Group-wise distribution of gender results was as in obstructive kidneys group the 43 (53.1 %) were male, and 38 (46.9 %) were female. In non-obstructive kidney group, the 33 (40.7 %) were male, and 48 (59.3 %) were female. There is a random distribution of gender in both the group. In response to complaints, there are different results in both the group. In obstructive kidney group 19 (13.5 %) have flank pain, 16 (19.8 %) have lower abdominal pain, 20 (24.7 %) have hematuria, 12 (17.3 %) have vomiting when pain and 14 (17.3 %) have renal colic.

In non-obstructive kidney group 17 (21.0 %) have flank pain, 14 (17.3 %) have lower abdominal pain, 11 (13.6 %) have hematuria, 20 (24.7 %) have vomiting when pain and 19 (23.5 %) have renal colic. Every patient has its own complaint. The mean score value of the resistive index in non-obstructive kidney group was 0.63 ± 0.02. The minimum score value was 0.60, and the maximum score value was 0.66. In obstructive kidney group, the mean value of the resistive index was 0.77 ± 0.03. The minimum score value was 0.73, and the maximum score value was 0.81. There is a significant difference between these two groups as the p value of the t test statistics is less than the level of significance.

Table 1: Group-wise descriptive statistics of age, history, and RI

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Obstructive Kidneys</td>
<td>81</td>
<td>41.42</td>
<td>11.85</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Non-obstructive Kidneys</td>
<td>81</td>
<td>39.1</td>
<td>12.06</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>History</td>
<td>Obstructive Kidneys</td>
<td>81</td>
<td>4.86</td>
<td>1.85</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Non-obstructive Kidneys</td>
<td>81</td>
<td>4.85</td>
<td>1.98</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>RI (Resistive Index)</td>
<td>Obstructive Kidneys</td>
<td>81</td>
<td>0.63</td>
<td>0.02</td>
<td>0.6</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td>Non-obstructive Kidneys</td>
<td>81</td>
<td>0.77</td>
<td>0.03</td>
<td>0.73</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Table 2: Group-wise distribution of Gender and complaints

<table>
<thead>
<tr>
<th></th>
<th>Obstructive Kidneys</th>
<th>Non-obstructive Kidneys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>43 (53.10 %)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>38 (46.90 %)</td>
</tr>
<tr>
<td>Complaints</td>
<td>Flank Pain</td>
<td>19 (23.50 %)</td>
</tr>
<tr>
<td></td>
<td>Lower abdominal pain</td>
<td>16 (19.80 %)</td>
</tr>
<tr>
<td></td>
<td>Hematuria</td>
<td>20 (24.70 %)</td>
</tr>
<tr>
<td></td>
<td>Vomiting when pain</td>
<td>12 (14.80 %)</td>
</tr>
<tr>
<td></td>
<td>Renal colic</td>
<td>14 (17.30 %)</td>
</tr>
</tbody>
</table>
Table 3: Descriptive group-wise statistics of RI (resistive index) and t-test results

<table>
<thead>
<tr>
<th>RI (Resistive Index)</th>
<th>Groups</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>t-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Obstructive Kidneys</td>
<td>81</td>
<td>0.63</td>
<td>0.02</td>
<td>0.6</td>
<td>0.66</td>
<td>-36.66</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Obstructive kidneys</td>
<td>81</td>
<td>0.77</td>
<td>0.03</td>
<td>0.73</td>
<td>0.81</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figures: Obstructive and non-obstructive kidneys

**Obstructive kidneys**

![Image 1](image1)

**Non-obstructive kidneys**

![Image 2](image2)
Discussion

In obstructive kidneys group, the mean age of the patients was 41.42 ± 11.85 years. Similarly, in non-obstructive kidney group, the mean values of age were 39.10 ± 12.06 years. These findings were matched with the studies (Conti et al. 2015; Dewitte et al. 2012). Group wise distribution of gender results was as in obstructive kidneys group the 43 (53.1 %) were male, and 38 (46.9 %) were female. In non-obstructive kidney group, the 33 (40.7 %) were male, and 48 (59.3 %) were female. In response to complaints, there are different results in both the group. Every patient has its own complaint.

The mean score value of the resistive index in non-obstructive kidney group was 0.63 ± 0.02. In obstructive kidney group, the mean value of the resistive index was 0.77 ± 0.03. These findings were like other studies (Basturk et al. 2012b; Kim et al. 2004; Nekouei et al. 2012; Bisi et al. 2017).

The role of renal arterial Doppler USG in the evaluation of acute renal obstruction is vigorously debated. A study showed an elevated RI in acutely obstructive kidneys, when compared with the RI in normal contralateral kidneys of the same patients. They also found similar results when acutely obstructive kidneys were compared with healthy subjects as control groups (Gurel et al. 2006).

Doppler ultrasonography considered as a gold standard modality for measurement of the resistive index in patients of obstructive and non-obstructive renal diseases. Few Studies have assessed the benefits of ultrasonography to measure R.I in obstructive kidneys. A study was conducted on the role of Diagnostic value of renal resistive index for the assessment of renal colic (Krumme & Hollenbeck 2007). Renal Doppler Ultrasonography performed on 70 patients. Group I comprised of 43 patients with unilateral ureteric obstruction due to stone, group II was comprised of 7 patients having flank pain, but no obstruction and group III was comprised of 20 healthy individuals with two normal kidneys.

Resistive Index was calculated using color Doppler ultrasound. RI was found to be 0.71±0.7 for group I, 0.69±0.06 for group II, and 0.62±0.03 for group III. So the RI of group I was higher than group II and III. No significant differences were noted with respect to age and gender.

This study shows that the measure of resistive index is useful for early identification of renal patients particularly for those who must avoid radiation and contrast (Kavakli, Koktener & Yilmaz 2011). A study was conducted on the role of Renal Arterial Resistive Index (RI) in obstructive uropathy. This study elaborates that Doppler is a non-invasive procedure and provides accurate results for the diagnosis of obstructive uropathy, the pressure on the renal calyces increases with the change in renal blood flow resulting in RI>0.7 (Kirkpantur et al. 2008).

160 patients were studied, among them, 103 were males, and 57 were females, 64 males and 37 females were identified as calculus obstructive RI>0.7 was observed in 84 patients. Out of them, 77 showed obstruction on CT KUB, but 7 didn't show obstruction on CT KUB RI<0.7 was observed in 76 patients, out of them 24 patient showed obstruction on CT KUB and 52 patients gave normal findings on CT KUB (Azam, Arfan & Beg 2013).

A study was conducted on Mean resistive index as a prognostic tool for hydronephrosis in patients with acute renal colic: a study in a tertiary care (Lerolle et al. 2006). They studied 84 patients who were admitted in the Emergency department of hospital due to unilateral renal colic. Some patients were presented with nausea and vomiting. Bladder ultrasound was performed along with color Doppler to measure the resistive index. There were 41 cases of hydronephrosis in total, and all of them were positive for mean resistive index value. Thus the specificity of the mean resistive index with color Doppler was 90%.

Around 95% of prediction was accurate with increased resistive index. They concluded that mean a resistive index is a good tool for the diagnosis of hydronephrosis (Ravindernath & Reddy 2017). There is a significant difference in RI (resistive index) of the renal artery in obstructive and non-obstructive kidneys. The results showed a difference in RI of both groups of kidneys. There are less researchers in literature on RI of renal artery and RAS, and these have positive effects on patient's treatment. These findings related with the findings of
(Guinot et al. 2013) that find RI is the main source of differentiate in normal and pathological resistance in flow. The results also proved that obstruction caused an increase in RI of renal artery and provided a reliable value to differentiate normal and pathological resistance to flow. There is significant difference between these two groups as the p value of the t test statistics is less than level of significance.

**Conclusion**

Doppler ultrasonography is advantageous because it is a non-invasive procedure and there is no exposure of radiation or iodinated contrast agents. This method is highly specific and sensitive. The sensitivity of Doppler ultrasound is round about 90%. It was concluded that calculi obstructive kidney caused prominent changes in the value of resistivity index as compared to the resistivity index of normal kidney. The effect of obstruction has caused elevation of resistivity index pattern.

**References**


