



Journal of Health and Medical Sciences

Maryam, Tehzeeb, Sattar, Ayesha, Shafiq, Tooba, Imran, Adil, Yasin, Shama, Tahira, Sadaf, Arooj, Madiha, Azam, Sadia, Ismail, Mishal, Farooq, Amna, Haider, Zeshan, Bacha, Raham, Ehtisham-Ul-Haq, Hafiz, and Khan, Muhammad. (2019), Doppler Comparison of Resistive Index of Renal Artery in Obstructive and Non Obstructive Kidneys. In: *Journal of Health and Medical Sciences*, Vol.2, No.3, 396-402.

ISSN 2622-7258

DOI: 10.31014/aior.1994.02.03.63

The online version of this article can be found at:
<https://www.asianinstituteofresearch.org/>

Published by:
The Asian Institute of Research

The *Journal of Health and Medical Sciences* is an Open Access publication. It may be read, copied, and distributed free of charge according to the conditions of the Creative Commons Attribution 4.0 International license.

The Asian Institute of Research *Journal of Health and Medical Sciences* is a peer-reviewed International Journal. The journal covers scholarly articles in the fields of Medicine and Public Health, including medicine, surgery, ophthalmology, gynecology and obstetrics, psychiatry, anesthesia, pediatrics, orthopedics, microbiology, pathology and laboratory medicine, medical education, research methodology, forensic medicine, medical ethics, community medicine, public health, community health, behavioral health, health policy, health service, health education, health economics, medical ethics, health protection, environmental health, and equity in health. As the journal is Open Access, it ensures high visibility and the increase of citations for all research articles published. The *Journal of Health and Medical Sciences* aims to facilitate scholarly work on recent theoretical and practical aspects of Health and Medical Sciences.



ASIAN INSTITUTE OF RESEARCH
Connecting Scholars Worldwide



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

Tehzeeb Maryam¹, Ayesha Sattar¹, Tooba Shafiq¹, Adil Imran¹, Shama Yasin¹, Sadaf Tahira¹, Madiha Arooj¹,
Sadia Azam¹, Mishal Ismail¹, Amna Farooq¹, Zeshan Haider¹, Raham Bacha¹, Hafiz Ehtisham-Ul-Haq¹,
Muhammad Khan¹

¹ University Institute of Radiological Sciences & Medical Imaging Technology, The University of Lahore,
Lahore, Pakistan

Correspondence: House No. 1231/59B, Street No. 1, Sabir Colony, Lakkar Mandi, Faizi Road, Multan.
E-mail: chowdry.ehtisham@gmail.com

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, urethral 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

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

Table 2: Group-wise distribution of Gender and complaints

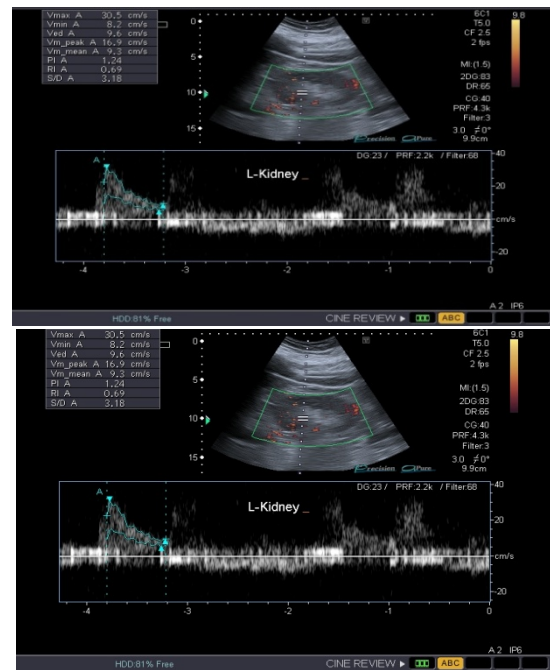
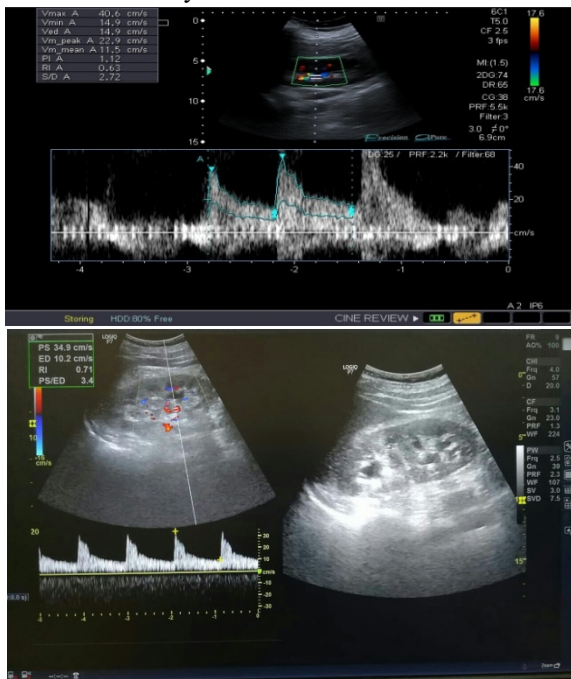
		Obstructive Kidneys	Non-obstructive kidneys
Gender	Male	43 (53.10 %)	33 (40.70 %)
	Female	38 (46.90 %)	48 (59.30 %)
Complaints	Flank Pain	19 (23.50 %)	17 (21.00 %)
	Lower abdominal pain	16 (19.80 %)	14 (17.30 %)
	Hematuria	20 (24.70 %)	11 (13.60 %)
	Vomiting when pain	12 (14.80 %)	20 (24.70 %)
	Renal colic	14 (17.30 %)	19 (23.50 %)

Table 3: Descriptive group-wise statistics of RI (resistive index) and t-test results

	Groups	n	Mean	SD	Min	Max	t-test	p-value
RI (Resistive Index)	Non Obstructive Kidneys	81	0.63	0.02	0.6	0.66	-36.66	0.000
	Obstructive kidneys	81	0.77	0.03	0.73	0.81		

Figures: Obstructive and non-obstructive kidneys

Obstructive kidneys



Non-obstructive kidneys



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 ± 0.07 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

- Azam, A, Arfan, H & Beg, MA 2013. 'Role of renal arterial resistive index (RI) in obstructive uropathy', *J Pak Med Assoc*, vol. 63, no. 12, pp. 1511-5.
- Aziz, ZA, Satchithananda, K, Khan, M & Sidhu, PS 2005. 'High-frequency color Doppler ultrasonography of the spermatic cord arteries: resistive index variation in a cohort of 51 healthy men', *J Ultrasound Med*, vol. 24, no. 7, pp. 905-9.
- Basturk, T, Akcay, M, Albayrak, R, Unsal, A, Ulas, T & Koc, Y 2012a. 'Correlation between the resistive index values of renal and orbital arteries', *Kidney Blood Press Res*, vol. 35, no. 5, pp. 332-9.
- Basturk T, Albayrak R, Ulas T, Akcay M, Unsal A, Toksoy M, et al. 2012b. 'Evaluation of resistive index by color Doppler imaging of orbital arteries in type II diabetes mellitus patients with microalbuminuria', *Ren Fail*, vol. 34, no. 6 pp. 708-12.
- Bellos I, Perrea DN, Kontzoglou K. 2019. 'Renal resistive index as a predictive factor of delayed graft function: a meta-analysis', *Transplant Rev (Orlando)*, vol. 33, no. 3, pp. 145-53.
- Beloncle F, Rousseau N, Hamel JF, Donzeau A, Foucher AL, Custaud MA, et al. 2019. 'Determinants of Doppler-based renal resistive index in patients with septic shock: impact of hemodynamic parameters, acute kidney injury and predisposing factors', *Ann Intensive Care*, vol. 9, no. 1, pp. 51.
- Bisi MC, do Prado AD, Piovesan DM, Bredemeier M, da Silveira IG, de Mendonca JA, et al. 2017. 'Ultrasound resistive index, power Doppler, and clinical parameters in established rheumatoid arthritis', *Clin Rheumatol*, vol. 36, no. 4, pp. 947-51.
- Bloch MJ, Basile J. 2003. 'The diagnosis and management of renovascular disease: a primary care perspective: part I. making the diagnosis', *J Clin Hypertens*, vol. 5, no. 3, pp. 210-8.
- Conti F, Ceccarelli F, Gigante A, Perricone C, Barbano B, Massaro L, et al. 2015. 'Ultrasonographic evaluation of resistive index and renal artery stenosis in patients with anti-phospholipid syndrome: two distinct mechanisms?', *Ultrasound Med Biol*, vol. 41, no. 7, pp. 1814-20.
- Dewitte A, Coquin J, Meyssignac B, Joannes-Boyau O, Fleureau C, Roze H, et al. 2012. 'Doppler resistive index to reflect regulation of renal vascular tone during sepsis and acute kidney injury', *Crit Care*, vol. 16, no. 5, pp. 165.
- Ellenbogen H, Scheible FW, Talner L, Leopold GR. 1978. 'Sensitivity of gray scale ultrasound in detecting urinary tract obstruction', *Am J Roentgenol*, vol. 130, no. 4, pp. 731-3.
- Guinot PG, Bernard E, Abou Arab O, Badoux L, Diouf M, Zogheib E, et al. 2013. 'Doppler-based renal resistive index can assess progression of acute kidney injury in patients undergoing cardiac surgery', *J Cardiothorac Vasc Anesth*, vol. 27, no. 5, pp. 890-6.
- Gurel S, Akata D, Gurel K, Ozmen MN, Akhan O. 2006. 'Correlation between the renal resistive index (RI) and nonenhanced computed tomography in acute renal colic: how reliable is the RI in distinguishing obstruction?', *J Ultrasound Med*, vol. 25, No. 9, pp. 1113-20.
- Kavakli H, Koktener A, Yilmaz A. 2011. 'Diagnostic value of renal resistive index for the assessment of renal colic', *Singapore Med J*, vol. 52, no. 4, pp. 271-3.
- Kim WS, Han TI, Kim SH, Park M, Kim IO, Yeon KM. 2004. 'Renal Doppler ultrasound examination of ureteral obstruction in rabbits: effects of different sites and degrees of obstruction on renal resistive index', *Invest Radiol*, vol. 39, no. 9, pp. 531-6.
- Kirkpantur A, Yilmaz R, Baydar DE, Aki T, Cil B, Arici M, et al. 2008. 'Utility of the Doppler ultrasound parameter, resistive index, in renal transplant histopathology', *Transplant Proc*, vol. 40, no. 1, pp. 104-6.

- Kojima M, Ochiai A, Naya Y, Okihara K, Ukimura O, Miki T. 2000. 'Doppler resistive index in benign prostatic hyperplasia: correlation with ultrasonic appearance of the prostate and infravesical obstruction', *Eur Urol*, vol. 37, no. 4, pp. 436-42.
- Krumme B, Hollenbeck M. 2007. 'Doppler sonography in renal artery stenosis--does the Resistive Index predict the success of intervention?' *Nephrol Dial Transplant*, vol. 22, no. 3, pp. 692-6.
- Lerolle N, Guerot E, Faisy C, Bornstain C, Diehl JL, Fagon JY. 2006. 'Renal failure in septic shock: predictive value of Doppler-based renal arterial resistive index', *Intensive Care Med*, vol. 32, no. 10, pp. 1553-9.
- Nekouei S, Ahmadnia H, Abedi M, Alamolhodae MH, Abedi MS. 2012. 'Resistive index of the remaining kidney in allograft kidney donors', *Exp Clin Transplant*, vol. 10, no. 5, pp. 454-7.
- Platt J, Rubin JM, Ellis JH. 1989. 'Distinction between obstructive and non-obstructive pyelocaliectasis with duplex Doppler sonography', *Am J Roentgenol*, vol. 153, no. 5, pp. 997-1000.
- Ravindernath M, Reddy GM. 2017. 'Mean resistive index as a prognostic tool for hydronephrosis in patients with acute renal colic: a study in a tertiary care', *Int J Adv Med*, vol. 4, no. 2, pp. 329-33.
- Rodgers P, Bates J, Irving H. 1992. 'Intrarenal Doppler ultrasound studies in normal and acutely obstructed kidneys', *Br J Radiol*, vol. 65, no. 771, pp. 207-12.
- Shokeir AA, Provoost AP, El-Azab M, Dawaba M, Nijman RJ. 1996a. 'Renal doppler ultrasound in children with normal upper urinary tracts: effect of fasting, hydration with normal saline, and furosemide administration', *Urology*, vol. 47, no. 5, pp. 740-4.
- Shokeir AA, Provoost AP, El-Azab M, Dawaba M, Nijman RJ. 1996b. 'Renal Doppler ultrasound in children with obstructive uropathy: effect of intravenous normal saline fluid load and furosemide', *J Urol*, vol. 156, no. 4, pp. 1455-8.
- Strandness D (ed.) 2000, *Doppler and ultrasound methods for diagnosis. Seminars in Nephrology*.
- Tublin ME, Bude RO, Platt JF. 2003. 'The resistive index in renal Doppler sonography: where do we stand?', *Am J Roentgenol*, vol. 180, no. 4, pp.885-92.