

Doppler of Renal Segmental Artery Resistive Index in Diabetic Patients

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Abstract

Background: Diabetic nephropathy affects 40 percent of patients with type I diabetes mellitus. It carries a poor prognosis when fully developed, where the estimated death rate is approximately 40-100 times that of non-diabetics. Vascular resistivity evaluation at multiple points of renal parenchyma can indicate structural or functional changes within the kidneys and can provide useful diagnostic and prognostic information. **Objective:** The goal of the research was to use renal artery Doppler to evaluate the mean renal resistivity index in patients with Diabetes Mellitus. **Methodology:** The research was initiated with the approval of the University of Lahore Ethical Committee. In this study, all the patients were registered after signing the informed consent form. Toshiba Xario was used with a convex probe of frequency of 3-5 MHz. Renal Resistive Index (RRI) was evaluated and sonographic data was kept in the ultrasound unit. The Statistical package for Social Sciences version 24 was used for analysing the data. **Results:** Among 97 patients, there were 66 females and 31 males of which 50 patients were with Diabetes and 47 were normal. In the result of our study it was seen that renal resistive index significantly increases in patients with Diabetes Mellitus. **Conclusion:** In conclusion, renal resistive index (RRI) levels were high in patients with Diabetes Mellitus showing positive correlation of RRI values

Keywords: Diabetic nephropathy, Renal resistive index, Chronic kidney disease

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Introduction

Diabetes mellitus is one of the most common chronic illnesses. The global prevalence of adult diabetes (20-79 years of age) was 6.4% in 2010 affecting 285 million adults and is expected to increase to 7.7% in 2030 affecting 439 million adults.¹ The average incidence of type 2 diabetes mellitus in Pakistan is 11.77 percent.² An approximately 3.4 million people died from the effects of high levels of fasting blood sugar in 2004.³ In underdeveloped countries, mortality rate due to diabetes is high at about 80%.⁴ More than half of diabetic patients suffer from kidney disorders. An evaluated 3.4 million people died from high levels of fasting blood sugar in 2004.⁴ In undeveloped countries due to diabetes, more than 80 percent of deaths occur.⁵

The major reason of end-stage kidney disease (ESRD) is diabetes mellitus.⁶ Diabetes Mellitus, due to the absence of insulin secretion or lower tissue sensitivity to insulin. It is a saccharide, fat and protein consumption deficiency disorder.⁷ Kidneys are one of the diabetes-affected organs. End stage renal disease (ESRD) bring about diabetes in various nations of the world. increased death rate in diabetes patients were in part because to increased direct and indirect kidney involvement.⁸ Length of kidney and its volume is obtained by ultrasound which is used for diagnostic purposes, Size of kidney depends on different parameters such as age, sex, BMI, and pregnancy. Size of kidney indicates its condition, function or physiology, and is used to indicate unilateral kidney disease by comparing with normal functioning kidney.⁷ Diabetic kidney disease can be defined as raised excretion of albumin in urine followed by increased blood pressure and reduction in glomerular filtration(GFR). The other modalities and multiple medications available are used for the evaluation of acute end-stage renal disease (ESRD).¹² One of the primary causes of chronic kidney disease (CKD) and end-stage renal disease (ESRD) is diabetic kidney disease.⁹ The major renal artery divides into segmental arteries near the hilum.¹⁰ Renal anatomy can be determined by a variety of means for assessment of renal disease.¹¹

In pulsed wave Doppler, the Resistive Index (RI) is used to calculate vascular resistance. A useful parameter for quantifying the changes in renal blood flow that may occur with renal disease is the Doppler Resistive Index (RI) ([peak systolic velocity-end diastolic velocity] / peak systolic velocity).¹⁵ Originally, RI was introduced to detect peripheral vascular diseases. In the analysis and management of aarteria renalis stenosis and renal graft incompatibility. RI has been documented to correspond with serum creatinine levels in patients with glomerulus-restricted renal diseases in patients with loss of kidney functioning. As an intrarenal arterial resistance index, the resistive index (RI) is widely used. The correlations of resistive index with renal function and patient prognosis have been seen in previous studies and RI rises in different kidney diseases.¹⁴

Methods

In this descriptive cross sectional study, 97 patients with and without diabetes mellitus were included. All the data

had been collected from University Ultrasound Clinic, Lahore. After informed consent data were collected by using Doppler ultrasound. Resistive index of right and left kidney was obtained. Inclusion criteria consist of patients of ages between 16-80 years with diabetes and non diabetic. Exclusion criteria consist of patients with hypertension and patients with any other focal renal pathology.

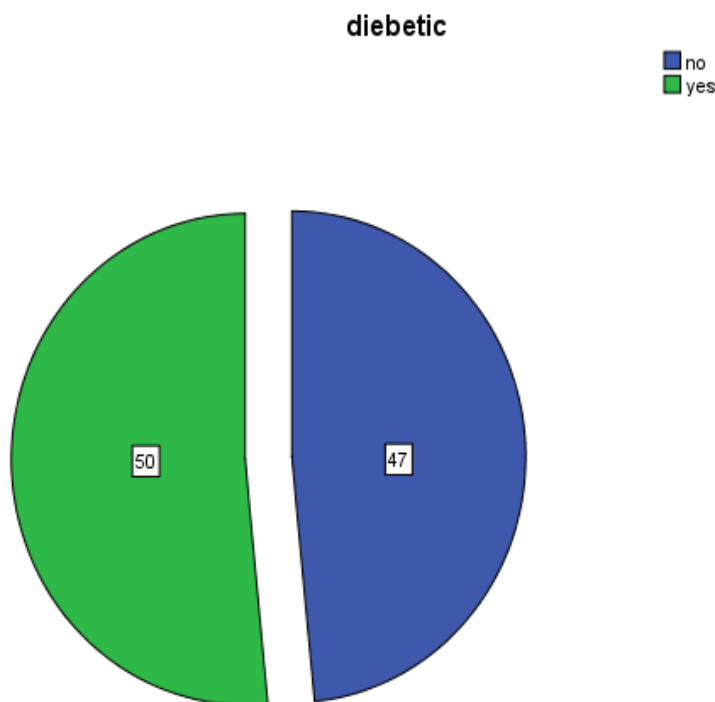
Results

RESULTS

The study included a total of 97 patients of whom 47 patients were non-diabetic and 50 patients were diabetic (Table 1)(Graph 1).

Diebetic	Frequency	Percent
Valid No	47	48.5
Yes	50	51.5
Total	97	100.0

Table 1: the frequency and percentage of diabetic and non diabetic patients



Graph 1: the frequency of normal and diabetic patient

Mean of RI of right kidney in normal (non diabetic) patients is 0.6074 ± 0.07164 . Mean of RI of right kidney in diabetic patients is $0.6342 \pm 0.5946.9$.(Table 2)

	diebetic	N	Mean	Std. Deviation	Std. Error Mean
RI right	No	47	.6074	.07164	.01045
	Yes	50	.6342	.05946	.00841

Table 2: mean of RI of right kidney in diabetic and non diabetic subjects

In Non Diabetic, mean of RI left kidney is 0.5853 ± 0.07132 . In Diabetic patients, mean of RI of left kidney is 0.6176 ± 0.10730 .(Table 3)

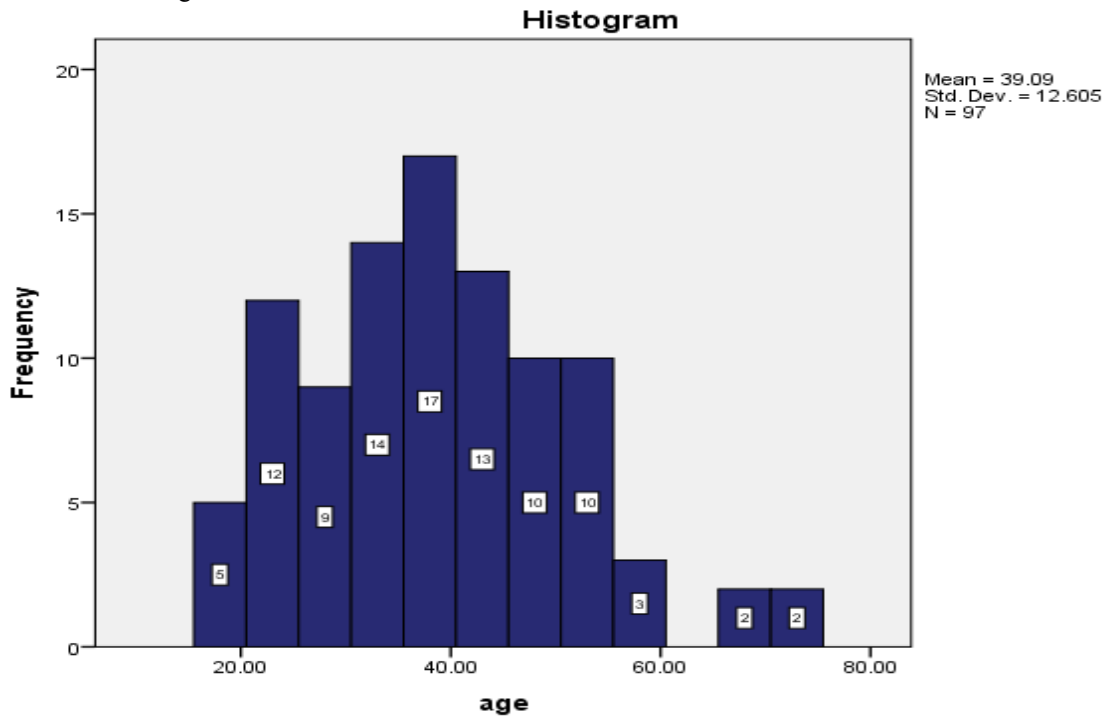
	diebetic	N	Mean	Std. Deviation	Std. Error Mean
RI left	No	47	.5853	.07132	.01040
	Yes	50	.6176	.10730	.01517

Table 3: mean of RI left kidney in diabetic and non diabetic subjects

This study included a total of 97 patients with the age range between 18-75 years, the mean age was 39,0928+12,60546.(Table 4)(Graph 2)

	N	Minimum	Maximum	Mean	Std. Deviation
Age	97	18.00	75.00	39.0928	12.60546

Table 4: mean of age

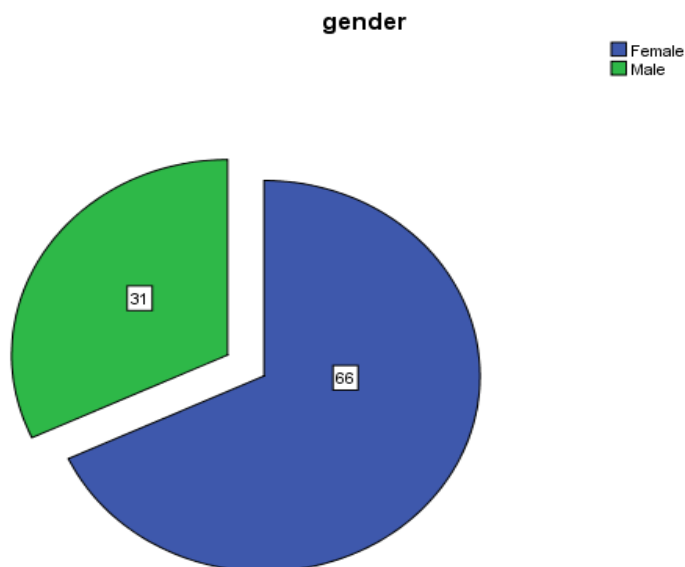


Graph 2: frequency and age of patients

Recent study include 97 patients, 66 (68%) females and 31(32%) males were enrolled.(Table 5)(Graph 3).

		Frequency	Percent
Valid	Female	66	68.0
	Male	31	32.0
	Total	97	100.0

Table 5: frequency and percentage of gender



Graph 3: frequency of gender

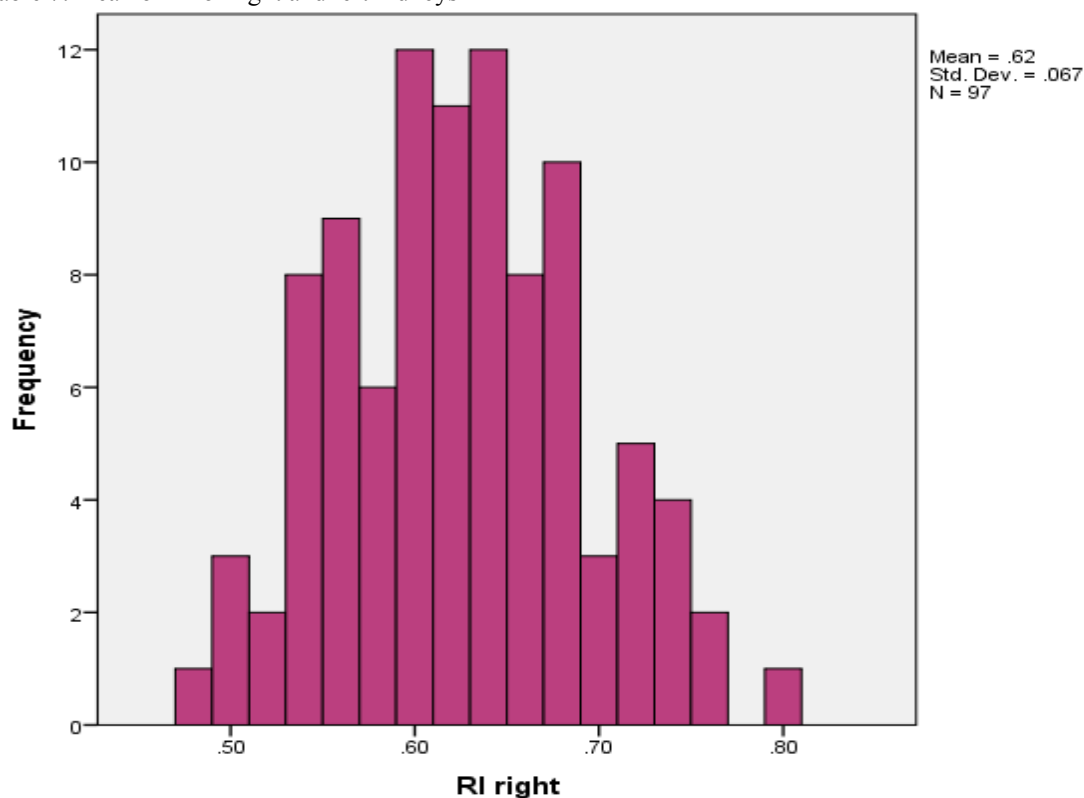
			Diebetic		Total
			No	yes	
Gender	Female	Count	25	41	66
		% within gender	37.9%	62.1%	100.0%
	Male	Count	22	9	31
		% within gender	71.0%	29.0%	100.0%
Total	Count		47	50	97
	% within gender		48.5%	51.5%	100.0%

Table 6: the cross tabulation of gender and diabetes

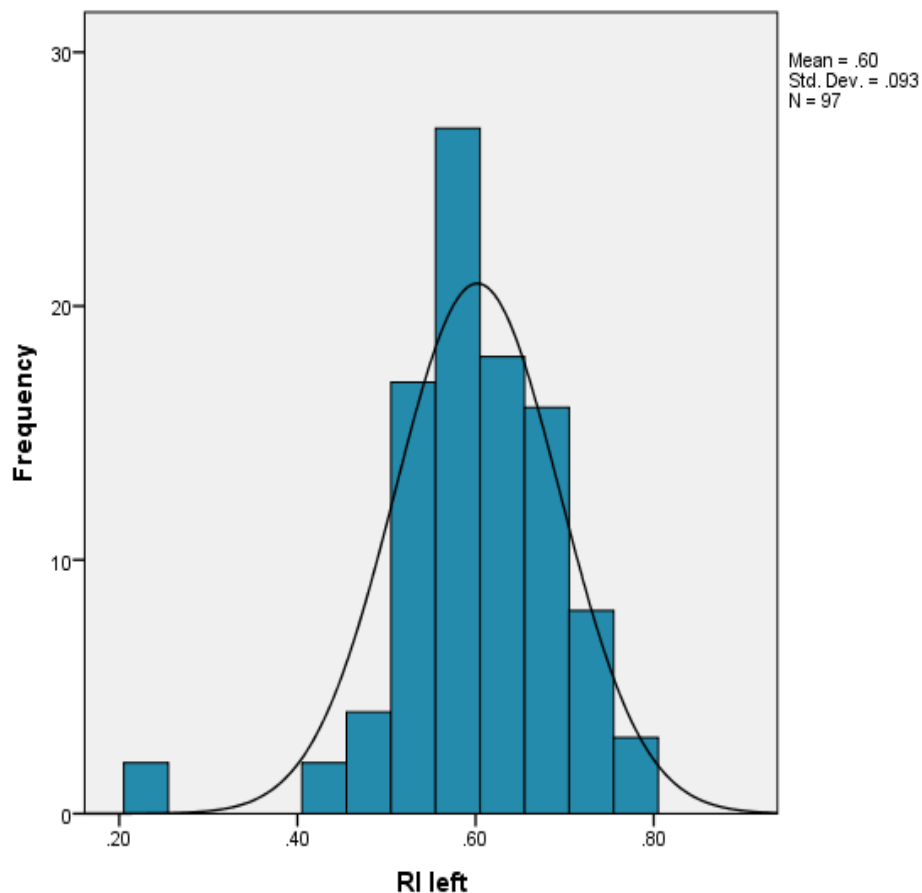
Results of (Table 7) and (Graph 4) shows that the mean RI of the right kidney is 0.6212 ± 0.06667 , where the maximum is 0.80 and the minimum is 0.48. Mean of RI of left kidney is 0.6020 ± 0.09261 in which 0.23 is minimum and 0.79 is maximum. (Graph5)

	N	Minimum	Maximum	Mean	Std. Deviation
RI right	97	.48	.80	.6212	.06667
RI left	97	.23	.79	.6020	.09261

Table 7: mean of RI of right and left kidneys



Graph 4: RI of right kidney



Graph 5: RI of left kidney

Independent sample T Test showed significant correlation between Diabetes Mellitus and Mean Renal RI in the right kidney(p is 0.048)(Table 8)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RI right	Equal variances assumed	1.283	.260	2.006	95	.048	-.02675	.01334	-.05323	-.00028
	Equal variances not assumed			1.995	89.591	.049	-.02675	.01341	-.05340	-.00010

Table 8: comparison of mean renal RI in diabetic and non diabetic subjects

Independent sample T test showed no significant correlation between DM and mean renal RI left kidney (Table 9).

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
RI Equal variances assumed	2.287	.134	-1.734	95	.086	-.03228	.01862	-.06925	.00469
RI Equal variances not assumed			-1.755	85.715	.083	-.03228	.01840	-.06886	.00429

Table 9: comparison of mean renal RI in diabetic and non diabetic subjects

DISCUSSION

Our study is focused on doppler of renal segmental artery resistive index in diabetic patients since Doppler US is a non invasive, less costly, easily available and repeatable modality that can help in diagnosis and assessment of severity of renal disease. Diabetes mellitus type 2 (DM 2) is one of the most frequent starting point of kidney dysfunction and the progression of long standing renal disease. The incidence is increasing day by day in our country because there is lack of proper screening and treatment. Due to poor socioeconomic condition of most patients they cannot afford the expense of costly renal function tests on a regular basis. Intrarenal arterial waveforms that have been widely used to examine renal dysfunction are recorded in Doppler Ultrasonography. Previous studies have shown that the measured blood flow velocity resistive index (RI) in vessels not only assesses improvements in intrarenal perfusion and renovascular resistance, but can also predict the development of hypertensive nephropathy.⁴¹

There were 97 patients in our research, of which 50 patients were diabetic and the other 47 were non-diabetic. The findings of our analysis indicate that the mean RI value was substantially different in patients with diabetes than in healthy patients. In the study performed by Sari A et al., the same findings are also examined as in our study in which the mean RI values vary in patients with diabetes versus normal patients.⁴² Univariate study evaluate that RI was associated remarkably with age. There were 97 patients with an age span of 18-75 years in the current report. There were 66 female patients and 31 male patients involved. The age median was 39.0928 + 12.60546. There were 194 patients in another study performed by Kawai T et al. 103 of the patients were women, 91 of whom were men. There was a mean age of 66.3 + 14.2 years. Females displayed a slight, but substantially, greater RI than in males.⁷ The findings of our research show that the age range is 18-75 years in which RI is significantly increased with age, similar to another study conducted by Hanamura K. et al, which shows that patients in the upper quartile showed significantly higher age when examined on the basis of different levels of RI.¹⁴

We had a total of 97 subjects in the current research, of which 47 were normal (non-diabetic) and 50 were diabetic. In normal patients, the mean RI of the right kidney was 0.6074 + 0.07164 and the mean RI of the right kidney in diabetic patients was 0.6342 + 0.05946. The mean Left Kidney RI of normal patients is 0.5853 + 0.07132 and the mean Left Kidney RI of patients with diabetes is 0.6176 + 0.10730.⁷

Study done by Jinadu Yo. have shown that there is a typical mean renal RI of about 0.60. A mean (±SD) RI of 0.60 ± 0.01 for patients without pre-existing kidney disease was recorded in the largest series to date (58 patients). Normal mean RI values of 0.64 ± 0.05 (21 patients), 0.58 ± 0.05 (109 kidneys), and 0.62 ± 0.04 (28 subjects) were also reported in three prior studies. As a whole, nearly all technologist now think about that 0.70 to be the upper threshold of the usual RI in adult. However, significant exceptions to this threshold were recorded. In infants, throughout the earliest year of life, it is normal for the mean RI to reach 0.70, and a mean RI larger than 0.70 can be seen throughout at least the earliest 4 years of life. In aged patients without renal insufficiency, the usual RI can also transcend 0.70. It is uncertain whether this is a normal situation, possibly due to age-related vascular compliance alteration, or due to ageing as a consequence of small vessel changes in the kidney. We have same findings in our study, it shows that the standard mean renal RI is 0.60.¹⁸

CONCLUSIONS

In conclusion, renal resistive index (RRI) levels were high in patients with diabetes mellitus.

References:

1. Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes research and clinical practice*. 2010;87(1):4-14.
2. Meo SA, Zia I, Bukhari IA, Arain SA. Type 2 diabetes mellitus in Pakistan: Current prevalence and future forecast. *JPMA. The Journal of the Pakistan Medical Association*. 2016;66(12):1637-42.
3. World Health Organization. *Global health risks: mortality and burden of disease attributable to selected major risks*. Geneva: World Health Organization;2009.
4. Bygberg IC. Double burden of noncommunicable and infectious diseases in developing countries. *Science*. 2012 Sep 21;337(6101):1499-501.
5. Afaf Mohamed Ahmed Medani1, Caroline Edward Ayad, MohammedElfadil Mohammed Garelnabi, Hussein Ahmed Hassan. *The Impact of Diabetes Mellitus on the Renal Parenchyma Measurements: ACT Based Study*
6. Sadowski EA, Djamali A, Wentland AL, Muehrer R, Becker BN, Grist TM, Fain SB. Blood oxygen level-dependent and perfusion magnetic resonance imaging: detecting differences in oxygen bioavailability and blood flow in transplanted kidneys. *Magnetic resonance imaging*. 2010;28(1):56-64.
7. Kawai T, Kamide K, Onishi M, Yamamoto-Hanasaki H, Baba Y, Hongyo K, Shimaoka I, Tatara Y, Takeya Y, Ohishi M, Rakugi H. Usefulness of the resistive index in renal Doppler ultrasonography as an indicator of vascular damage in patients with risks of atherosclerosis. *Nephrology Dialysis Transplantation*. 2011;26(10):3256-62
8. Shahbazian H, Rezaii I. Diabetic kidney disease; review of the current knowledge. *Journal of renal injury prevention*. 2013;2(2):73
9. T.Z. Min, M.W. Stephens, P. Kumar, R.A. Chudleigh, *Renal complications of diabetes, British Medical Bulletin*, Volume 104, Issue 1, 2012, Pages 113–127
10. Kang WY, Sung DJ, Park BJ, Kim MJ, Han NY, Cho SB, Kang CH, Kang SH. Perihilar branching patterns of renal artery and extrarenal length of arterial branches and tumour-feeding arteries on multidetector CT angiography. *The British journal of radiology*. 2013;86(1023):20120387.
11. Ahmed S, Bughio S, Hassan M, Lal S, Ali M. Role of Ultrasound in the Diagnosis of Chronic Kidney Disease and its Correlation with Serum Creatinine Level. *Cureus*. 2019;11(3).
12. Zhang JL, Morrell G, Rusinek H, Sigmund EE, Chandarana H, Lerman LO, Prasad PV, Niles D, Artz N, Fain S, Vivier PH. New magnetic resonance imaging methods in nephrology. *Kidney international*. 2014;85(4):768-78.
13. McArthur C, Geddes CC, Baxter GM. Early measurement of pulsatility and resistive indexes: correlation with long-term renal transplant function. *Radiology*. 2011;259(1):278-85.
14. Hanamura K, Tojo A, Kinugasa S, Asaba K, Fujita T. The resistive index is a marker of renal function, pathology, prognosis, and responsiveness to steroid therapy in chronic kidney disease patients. *International journal of nephrology*. 2012;2012.
15. Maksoud AA, Sharara SM, Nanda A, Khouzam RN. The renal resistive index as a new complementary tool to predict microvascular diabetic complications in children and adolescents: a groundbreaking finding. *Annals of translational medicine*. 2019;7(17).
16. Tublin ME, Bude RO, Platt JF. The resistive index in renal Doppler sonography: where do we stand?. *American Journal of Roentgenology*. 2003 Apr;180(4):885-92.
17. Sari A, Dinc H, Zibandeh A, TELATAR M, GÜMELE HR. Value of resistive index in patients with clinical diabetic nephropathy. *Investigative radiology*. 1999 Nov 1;34(11):718.
18. Jinadu Yo. Resistive index in diagnosis and assessment of renal function loss in diabetic nephropathy. *Faculty of internal Medicine* 2015.

