DETERMINATION OF RENAL RESISTIVITY INDEX IN PATIENTS HAVING TYPE II DIABETES MELLITUS

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ABSTRACT

Objective: To determine mean renal resistivity index using renal artery Doppler in patients having type 2 diabetes mellitus.

Study Design: Cross-sectional study.

Place and Duration of Study: Armed Forces Institute of Radiology and Imaging Rawalpindi, from Jan 2016 to Jul 2016.

Methodology: One hundred and fifty patients diagnosed with Type II Diabetes mellitus were included in this study. Renal resistivity index of both the kidneys at the level of segmental arteries was measured through color Doppler system (SSA-580A Toshiba, Japan) equipped with a transducer 3.75 MHz. At least two readings taken each at upper, mid and lower pole and average resistivity index was calculated. HbA1c levels were carried out through standard lab procedures.

Results: Mean age of the patients was 54.06 ± 8.27 years. Out of 150 cases, 87 patients (58.0%) were male and 63 patients (42.0%) were female. Mean duration of diabetes was 5.53 ± 2.22 years. Mean HbA1c was 7.58 ± 1.02. Mean renal resistivity index of right kidney was 0.72 ± 0.02, mean renal resistivity index of left kidney was 0.72 ± 0.03 and average of both kidneys' mean renal resistivity index value was 0.72 ± 0.02.

Conclusion: Renal resistivity indices were high in patients with type 2 diabetes. This signifies that renal Doppler ultrasounds may be used as a non-invasive marker to identify patients with diabetes who have high risk of developing early nephropathy and thus may contribute to timely diagnosis and control disease progression.

Keywords: Diabetic nephropathy, Renal resistivity index, Type II diabetes mellitus.

INTRODUCTION

Diabetes mellitus is defined as one of the metabolic disorders that is characterized by symptoms ensuing from defects in internal secretion or faulty action of insulin or both. Type 2 diabetes prevalence in Pakistan is on the increase and the risk seems to be related with co-morbids like obesity, family history of diabetes mellitus and hypertension[1]. Pakistan is considered to be one of the countries with the biggest diabetes population and is ranked tenth globally by the International Diabetes Foundation[2]. The prevalence of diabetes is high in Pakistan reported to be about 11%3. Type 2 diabetes is one in all the leading causes of chronic renal disease worldwide, and diabetic nephrosis has become a significant international public health issue[4]. Prevalence rates of diabetic kidney disease and incidence rates of diabetes mellitus are increasing parallely. Without sufficient sincere betterment in prevention and treatment methods, prevalence will continue to rise[5]. The reasons for unsatisfactory management include delay in diagnosis, lack of aggressive interventions, and limited knowledge about efficacy of these interventions. Diabetic Nephropathy is a comparatively prevalent microvascular complicationin diabetic population. Approximately 40% of diabetic patient suffer from diabetic kidney disease and it has been found to be the leading cause ofchronic nephrosis worldwide[6]. At the end of 2003, 1.7 million patients with chronic kidney diseases (CKD) had entered end-stage renal disease (ESRD) and about 76% of these were undergoing dialysis treatment,

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thus reflecting the huge disease burden. This number continues to grow at a significantly higher rate than the world population. Detection of diabetics prone to develop nephropathy is essential to implement steps in time thus slowing down CKD progressionand avoiding secondary complications[7].

Ultrasonography with color Doppler has enabled noninvasive evaluation of renal perfusion changes by interrogating intra renal arteries. Among Doppler Ultrasound parameters RI value is considered the most useful and frequently used. It quantifies the changes in renal blood flow that may occur with renal disease. The renal resistive index (RRI) values obtained by analyzing the arterial waveform area non-invasive and reproducible measure to investigate renal blood flow dynamics. It is calculated by using the following equation: ([peak systolic velocity-end diastolic velocity]/peak systolic velocity) (fig-1) RRI assesses renal arterial resistanceby the flow velocity variability generated by the pulsatile arterial perfusion[8]. Adult normal RRI values are 0.47 to 0.70 with a difference between two kidneys of 5-8%[9]. This study calculated RRI of diabetics in our population. Since increased RI valuesmatch closely with the progression of chronic renal disease and the onset of proteinuria[10]. Rationale of the study was that if RRI is found higher in diabetics this would provide evidence that assessment of RRI in routine is important in diabetic population for early detection of diabetic nephropathy to prevent irreversible renal dysfunction.

METHODOLOGY

We conducted a cross sectional study on patientshaving type II diabetes visiting Armed Forces Institute of Radiology and Imaging Rawalpindi from January 2016 to July 2016, after approval from institutional review board. A total of 150 patients participated in this study. By using prevalence of 11% in Pakistan 3, sample size was calculated manually using formula z2p (1-p)/d2, keeping design effect at 50% and 95% confidence interval.

Non probability consecutive sampling technique was used in the study. Patients having hypertension, diabetic nephropathy (macro albuminuria, i.e. urine albumin levels of >300 µg/mg), eGFR <60 poor corticomedullary differentiation on ultrasound, renal atrophy,patients who had undergone any urinary tract surgery and obese patients (BMI >40 kg/m^2) were excluded.

The study was explained to the patients followed by consent taken from the willing patients. All willing patients were subjected to renal artery Doppler examination in suspended respiration. At least two measurements taken in upper, mid and lower segmental arteries of each kidney and average was calculated. RRI was measured through color Doppler system (SSA-580A Toshiba, Japan) equipped with a 3.75 MHz curved array transducer. Standard laboratory procedures were applied to carry out HbA1c and urine albumin levels. All the data was recorded

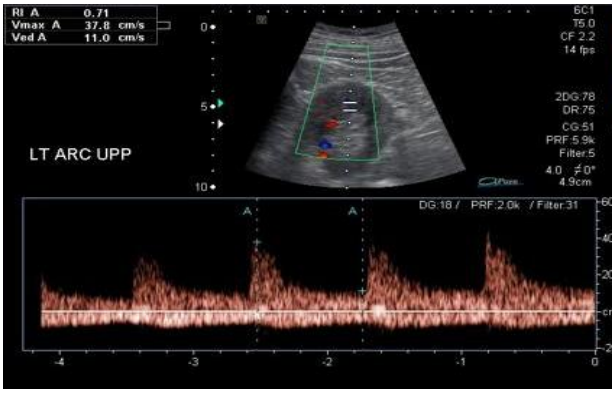

Figure-1: Left upper pole arcuate artery doppler showing RI 0.7.

in a specially prepared proforma. Confidentiality of the patient's record was maintained.

All the data was analyzed in the SPSS version 15.0. Mean and standard deviation were derived for quantitative data whereas frequency and percentages were obtained for qualitative variables. Independent sample t-test was applied after stratification. Cut off of *p*-value was kept at ≤0.05 to be taken as significant.

RESULTS

Mean RRI of right kidney was 0.72 ± 0.02; mean RRI of left kidney was 0.72 ± 0.03 and

average of both kidneys' mean RRI valuewas 0.72 ± 0.02. The mean age of patients was 54.06 ± 8.27 year with ages ranging between 35-65 years. Out of 150 cases, 87 (58.0%) were male and 63 (42.0%)

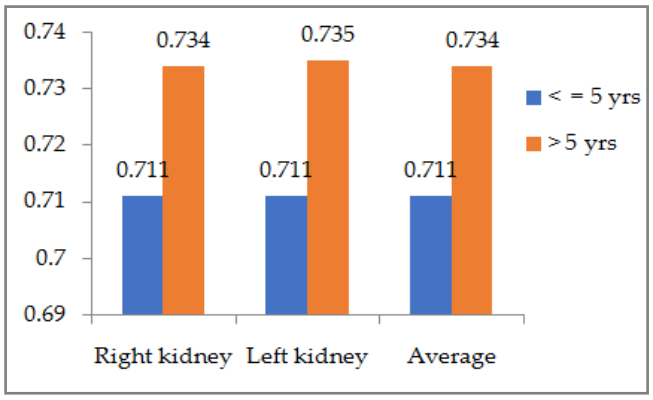

Figure-2: Renal resistivity index for duration of diabetes.

were female. Mean duration of diabetes was 5.53 ± 2.22 years. Mean HbA1c was 7.58 ± 1.02. There was statistically significant increase in RRI in patients having duration of diabetes >5 years (fig-2) (table-I). Average RRI in patient having HbA1c levels >7.5% was 7.4 as compared to 7.1 in patients having HbA1c 6.5-7.5%.

Table-I: Renal resistivity index for duration of diabetes.

Kidney	Duration (year)	Renal resistivity index (Mean ± SD)	*p*-value
Right Kidney	<5 n=89	0.711 ± 0.024	*p*<0.001
	>5 n=61	0.734 ± 0.028	
Left Kidney	<5 n=89	0.711 ± 0.026	*p*<0.001
	>5 n=61	0.735 ± 0.031	
Average of both sides	<5 n=89	0.711 ± 0.024	*p*<0.001
	>5 n=61	0.734 ± 0.028	

Table-II: The difference was found to be statically significant with *p*-value of <0.001.

Kidney	HbA1c	RRI Mean ± SD	*p*-value
Right Kidney	6.5-7.5%	0.710 ± 0.023	*p*<0.001
	> 7.5%	0.738 ± 0.029	
Left Kidney	6.5-7.5%	0.711 ± 0.026	*p*<0.001
	> 7.5%	0.741 ± 0.033	
Average of both sides	6.5-7.5%	0.710 ± 0.022	*p*<0.001
	> 7.5%	0.739 ± 0.030	

Renal resistivity index for HbA1c levels.

DISCUSSION

With the increasing prevalence of diabetes worldwide and subsequently rising incidence of diabetic kidney disease; it is the need of time to identify tools and means helpful for early identification and thus timely management of diabetic nephropathy improving patient outcome. Ultrasound Doppler is widely used in diagnostic, prognostic and therapeutic assessments of renal ailments. It is preferredbecause of being a non-invasive and cost friendly method for renal blood flow assessment[11]. Diabetes is one of the most prevalent causes of renal disease internationally and accounts presently for half of prevalent kidney failure which was initially reported to be 18% in 1980[12].

In early stages of diabeticvasculopathy there is loss of endothelial control on vascular tone, the early assessment of which is possible by using renal resistivity index[13]. Increasing evidence suggests that the renal RIpredicts the course of renal functions in many conditions. Studies have shown that RI being an index of renal vascular resistance other than proving to bean early marker for recognition of diabetic nephropathy; is also effective at predicting patients at risk in future. Resistive index values have been found to be increased in diabetics even before appearance of microalbuminuria[14].

Patients with diabetes show renal volume and hemodynamic alteration on ultrasound, irrespective of proteinuria, signs of atherosclerotic

disease and raised GFRs,thus indicating pertinent role of duplex sonography in identifyingrenal morphologic and hemodynamic modifications in patients having type-II diabetes[15]. Picking up diabetic kidney disease early and thus intervening in time can help improve survival and quality of life in patients having type II diabetes by slowing renal function decline, preventing complications, and decreasing cardiovascular events.

In a study conducted by Kawai *et al*, it has been shown that raised RRI (>0.7) significantly correlates with age, eGFR, and albuminuria levels. Patients with diabetes mellitus (DM) showed significantly raised resistivity index than non-diabetics, although their eGFR was same; thus concluding that DM leads to renal vascular damage which could be detected by RIearly; precedingreduction ineGFR[16].

Recently huge progress has been made in interpreting the risk factors and mechanisms of diabetic nephropathy. Advances have also been made in treatment strategies to prevent or slow down the progression of diabetic nephropathy making its early detection all the more important[17].

Our results were comparable to similar studies carried out at regional and international levels in which RRI has been shown to be an effective early predictor of renal damage in patients with diabetes whether adults or children[9]. A study done by Piernicola *et al*, in Italy showed that early changes in renal hemodynamics are detectable on Doppler sonography in children with diabetes without any evidence of renal dysfunction and may suggest a preclinical stage of diabetic nephropathy[19]. Studies carried out in Turkey[18], and Iran[20], have proven that a significant positive relation exists between rise in renal resistivity index and proteinuria in patients with diabetes. There is a need to carry out similar studies in other parts of the country so that a strong conclusion can be derived and the management protocols can be revisited accordingly.

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CONCLUSION

In conclusion, renal resistive index (RRI) levels were high in patients with type-2 diabetes showing positive correlation of RRI values with duration of diabetes and with HbA1 values, signifying that assessment of renal resistivity index using renal Doppler ultrasounds may non-invasively help in timely identification of high risk diabetic patients for nephropathy, early clinical intervention for preventing disease progression, better outcome and prognosis.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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