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CORRELATION OF RENAL RESISTIVE INDEX WITH SERUM CREATININE AND ALBUMINURIA IN PATIENTS OF DIABETIC NEPHROPATHY

Original Research

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ABSTRACT

Background: One metabolic disease known as diabetes mellitus is typified by symptoms resulting from either incorrect insulin action, problems in internal secretion, or both. The frequency of type 2 diabetes is rising in Pakistan, and co-morbid conditions including obesity, a family history of the disease, and hypertension appear to enhance the chance of developing the condition. One severe microvascular consequence of diabetes mellitus is diabetic nephropathy. According to estimates, diabetics are significantly more likely than non-diabetics to die from renal failure.

Objective: To determine correlation of renal resistive index with serum creatinine and albuminuria in patients of diabetic nephropathy.

Methodology Setting: Department of diagnostic radiology, Combined Military Hospital Malir.

Study design: Cross-sectional study

Duration: 6-months after approval of synopsis.

Sample size: 190 patients was calculated through STATA 15 using formula for one sample correlation. The study was conducted after permission from ethical review committee. A total of 190 patients referred to diagnostic radiology department for ultrasound KUB/abdomen, fulfilling the inclusion criteria, were enrolled after informed consent. The baseline characteristics including age, gender, duration of diabetes, hypertension and smoking were recorded. A real-time B-scan were used to view the kidneys first, followed by a duplex Doppler ultrasonography to check the intrarenal arteries. Each kidney's upper, middle, and lower intrarenal arteries had at least three measurements made. The machine used a predefined calculation to determine the RI value.

Results: There were 85 (44.7%) females and 105 (55.3%) males. Hypertension was reported by 68.9% of respondents. Smoking prevalence was lower, with 37.4%. The average duration of diabetes is 8.6 ± 2.5 years, with a range of 5 to 15 years. A measure of kidney vascular resistance, the renal resistive index (RRI) has a mean of 0.71 ± 0.04 and a narrow range of 0.60 to 0.80.

Conclusion: It is concluded, our study supports the use of RRI as a valuable, non-invasive marker that correlates well with serum creatinine and albuminuria in diabetic nephropathy.

Key Words: Hypertension, renal resistive index RRI, serum creatinine and albuminuria, diabetic nephropathy.

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INTRODUCTION

One metabolic disease known as diabetes mellitus is typified by symptoms resulting from either incorrect insulin action, problems in internal secretion, or both. The frequency of type 2 diabetes is rising in Pakistan, and co-morbid conditions including obesity, a family history of the disease, and hypertension appear to enhance the chance of developing the condition[1]. By the International Diabetes Foundation, Pakistan is ranked tenth in the world for diabetes prevalence and is one of the countries with the highest diabetes population[2]. Diabetes is chronic health problem and Pakistan is struggling with it over the past several years. Diabetes is hard to control as reported about 11%[3] of the population is suffering.

One severe microvascular consequence of diabetes mellitus is diabetic nephropathy. According to estimates, diabetics are significantly more likely than non-diabetics to die from renal failure[4]. It is distinguished by the increasing renal failure, hypertension, and proteinuria clinical condition[5]. Without a kidney biopsy, diabetic nephropathy is often diagnosed clinically. Furthermore, biochemical tests such urine albumin, serum creatinine, creatinine clearance, and urine analysis are advised[6].

The prevalence of DKD and the incidence of DM are on parallel rise. Prevalence will keep on increasing[7] if there is not considerable true betterment with respect to the modalities of prevention and treatment. There are multiple reasons for poor management: (a) due to diagnostic delay (b) inappropriate interventions have not been initiated (c) the experience of effectiveness with these interventions is a limitation. Diabetic kidney disease is a complication that affects about 40% of people with diabetes and has been described as a common cause of chronic nephrosis worldwide[8].

Duplex resistant indices (RI) When it comes to serious renal problems, Doppler ultrasonography offers a high-quality, non-invasive display of significance. It offers a metric for evaluating the functioning state of the kidneys. The intrarenal artery's average RI value is between 0.53 to 0.68. A RI value of 0.70 or above is regarded as abnormal[9]. When duplex and conventional doppler ultrasonography are compared, duplex When it comes to identifying renal anomalies in both clinically silent and obvious diabetic nephropathy, Doppler ultrasonography is better than traditional scanning[10]. In diabetic patients, RI levels begin to rise even before microalbuminuria manifests[11].

In order to diagnose renal impairment in 53 diabetic individuals, Shirin M. et al. assessed renal RI using duplex Doppler ultrasonography. With a mean resistive index of 0.71±0.04, 73.6% of diabetic individuals had a resistive index of (≥ 0.7). The resistive index showed a positive connection with both albuminuria ($r=0.725$, $p<0.01$) and serum creatinine ($r=0.581$, $p<0.01$)[12.]

Lotfinejad M. et al. examined data from 82 diabetic patients, who ranged in age from 17 to 67. They found a significant ($P < 0.05$) association of 0.37 between RI and Cr level and 0.75 ($P > 0.05$) between RI and albuminuria in diabetic individuals [13].

Diabetic nephropathy is predicted to increase as the prevalence of diabetes rises globally. Therefore, it is very desirable to have a highly specific, non-invasive, and reliable diagnostic tool for identifying minor renal alterations that might indicate the existence of diabetic nephropathy.

Therefore, the purpose of this study is to assess the diagnostic utility of renal resistive index using duplex Doppler ultrasonography by comparing it to blood creatinine levels and albuminuria in diabetes patients who present to our local setting. According to the study's findings, doppler scans, a non-invasive diagnostic technique, can be used to both detect diabetic nephropathy early on and track its development.

The current study, which examines the relationship between renal resistive index and blood creatinine and albuminuria in individuals with diabetic nephropathy, was designed due to a lack of understanding about the condition.

OBJECTIVE

To determine correlation of renal resistive index with serum creatinine and albuminuria in patients of diabetic nephropathy.

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METHODOLOGY:

This study was conducted in Department of diagnostic radiology, Combined Military Hospital Malir. It was a cross-sectional study. It was a study of 6 months after approval of synopsis. Sample sized is calculated through STATA 15 using formula for one sample correlation. Where,

Correlation between renal resistive index and serum creatinine, $r_0 = 0.58$

Alternate correlation, $r_a = 0.70$ Power of the study = 80%

Significance level = 5% Sample size = **190**

It was a Non-probability consecutive sampling, with inclusion criteria Age 35 – 70 years, either male or female gender. Known cases of diabetes mellitus (history and medical record), for ≥ 5-year. Diagnosed with diabetic nephropathy, as per operational definition and exclusion criteria Patients with single kidney, renal artery stenosis (medical record). Pregnant women. Patients already on ACE inhibitor therapy.

The study was conducted after permission from the ethical review committee. A total of

190 patients referred to diagnostic radiology department for ultrasound KUB/abdomen, fulfilling the inclusion criteria, were enrolled after informed consent. The baseline characteristics including age, gender, duration of diabetes, hypertension and smoking were recorded. A real-time B-scan was used to view the kidneys first, followed by a duplex Doppler ultrasonography to check the intrarenal arteries. Each kidney's upper, middle, and lower intrarenal arteries had at least three measurements made. The machine used a predefined calculation to determine the RI value. Duplex Doppler will only be used to evaluate individuals with the highest RI values. Following that, each patient will provide a urine sample for the measurement of spot albumin and a blood sample for the measurement of serum creatinine. Every piece of information gathered will be documented on the proforma attached.

DATA ANALYSIS

The SPSS version 23.0 was used to analyze the data. The Shapiro-Wilk test was used to determine if the numerical data was normal. Serum creatinine, urine albumin, renal resistive index, age, and length of diabetes were all displayed as mean ± standard deviation. The frequency and proportion of smoking, hypertension, and gender were compiled. Pearson correlation analysis was used to look at the correlation (r) between the RI and serum creatinine and urine albumin, and a p-value of less than 0.05 was considered significant. To ascertain the impact on association between the RI and serum creatinine and urine albumin, the data were stratified by age groups, gender, duration of diabetes, hypertension, and smoking. Pearson correlation (r) after stratification was computed, and a p-value of less than 0.05 was considered significant.

RESULTS:

The mean age of the patients in control group was 51.7 ± 7.4 years with age range from 35 to 70 years. There were 85 (44.7%) females and 105 (55.3%) males.

Table 1: Age distribution of study participants

Parameter	Mean ± SD	Min.	Max.
Age (years)	51.7 ± 7.4	35.0	70.0

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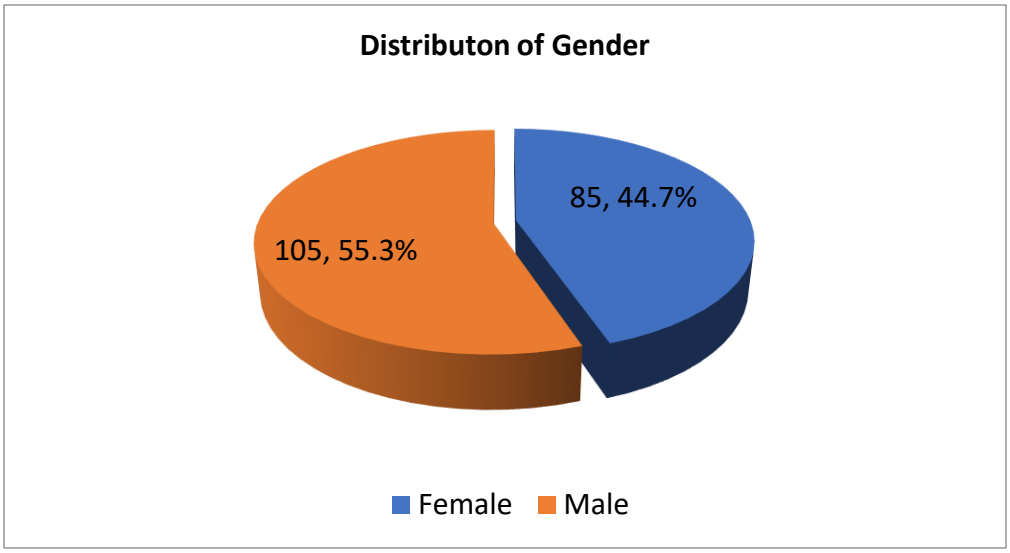

Figure 1: Gender distribution of study participants

Hypertension was reported by 68.9% of respondents (n=131), while only 31.1% (n=59) were non-hypertensive. Smoking prevalence was lower, with 37.4% (n=71) and a majority of 62.6% (n=119) as non-smokers. (Table 2)

Table 2: Frequency of Hypertension and Smoking Among Study Participants

Parameter	Category	Frequency	Percentage
Hypertension	Yes	131	68.9
	No	59	31.1
Smoking	Yes	71	37.4
	No	119	62.6

Descriptive data for four important clinical factors among 190 diabetic individuals is shown in Table 3. The average duration of diabetes is 8.6 ± 2.5 years, with a range of 5 to 15 years. A measure of kidney vascular resistance, the renal resistive index (RRI) has a mean of 0.71 ± 0.04 and a narrow range of 0.60 to 0.80. With a mean of 0.86 ± 0.10 mg/dL, serum creatinine values, which indicate renal function, vary from 0.60 to 1.20 mg/dL. With a mean of 493.8 ±60.0 mg/day, urinary albumin excretion, a sign of renal impairment, ranges greatly (348–669 mg/day).

Table 3: Descriptive Statistics of Diabetes Duration and Renal Function Parameters

Parameter	Mean ± SD	Min.	Max.
Duration of diabetes (years)	8.6 ± 2.5	5.0	15.0
RRI	0.71 ± 0.04	0.60	0.80
S. creatinine mg/dL	0.86 ± 0.10	0.60	1.20
Urinary albumin (mg/day)	493.8 ± 60.0	348.0	669.0

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In individuals with diabetic nephropathy, the correlation analysis showed a substantial relationship between the Renal Resistive Index (RRI) and indicators of renal function. Serum creatinine levels and RRI showed a moderately positive connection ($r = 0.490$, $p < 0.001$), suggesting that greater serum creatinine, a sign of deteriorating renal function, is linked to higher RRI values. RRI and urine albumin excretion also showed a small but statistically significant negative correlation ($r = -0.257$, $p < 0.001$), indicating a minor association between lower RRI values and greater albuminuria. RRI, on the other hand, did not significantly correlate with either illness duration ($r = -0.058$, $p = 0.429$) or age ($r = 0.087$, $p = 0.230$). (Table 4)

Table 4: Correlation of renal resistive index with age, disease duration, serum creatinine and albuminuria in patients with diabetic nephropathy

Renal Resistive Index	Age (years)	Disease Duration (years)	Serum creatinine (mg/dl)	Urinary albumin (mg/day)
Correlation coefficient (r)	0.087	-0.058	0.490	-0.257
p-value	0.230	0.429	< 0.001*	< 0.001*

*Significant

Across all groupings, stratified analysis showed persistent and statistically significant positive associations between blood creatinine levels and the Renal Resistive Index (RRI). A modest association ($r = 0.411$, $p < 0.001$) was seen among patients under 50, while a somewhat larger correlation ($r = 0.535$, $p < 0.001$) was found among patients over 50. The results were similar for both gender and comorbidities: the correlation was higher for men ($r = 0.609$, $p < 0.001$) than for females ($r = 0.349$, $p = 0.001$), and the relationships were significant for individuals with illness durations of 5–10 years ($r = 0.515$, $p < 0.001$) or 11–15 years ($r = 0.426$, $p = 0.001$). Strong associations were seen between smokers ($r = 0.402$, $p = 0.001$) and non-smokers ($r = 0.546$, $p < 0.001$), as well as between hypertension ($r = 0.516$, $p < 0.001$) and non-hypertensive individuals ($r = 0.429$, $p = 0.001$).

RRI and urine albumin excretion, on the other hand, had a weaker and more varied relationship across subgroups. The majority of strata, including patients aged ≤50 years ($r = -0.327$, $p = 0.002$), >50 years ($r = -0.193$, $p = 0.047$), males ($r = -0.258$, $p = 0.008$), and females ($r = -0.268$, $p = 0.013$), showed statistically significant negative associations. Stronger negative correlations were also seen in patients without hypertension ($r = -0.359$, $p = 0.005$) and those with disease durations of 11–15 years ($r = -0.378$, $p = 0.003$). Smoking may have an impact on this association, as evidenced by the fact that the correlation between RRI and urine albumin was not statistically significant among smokers ($r = -0.195$, $p = 0.103$). All things considered, the results confirm the robust correlation between RRI and serum creatinine across clinical and demographic characteristics, although the correlation with urine albumin is less pronounced and might be impacted by additional variables including smoking status.

Table 5: Stratified Correlation of Renal Resistive Index with Serum Creatinine and Urinary Albumin in Diabetic Nephropathy Patients

Parameter	Stratification	Serum creatinine (mg/dl)	p-value	Urinary albumin (mg/day)	p-value
Age	**≤ 50 years**	0.411	< 0.001*	-0.327	0.002*
	> 50 years	0.535	< 0.001*	-0.193	0.047*
Gender	**Male**	0.609	< 0.001*	-0.258	0.008*
	Female	0.349	0.001*	-0.268	0.013*
Disease Duration	**5 – 10 years**	0.515	< 0.001*	-0.194	0.026

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	11 – 15 years	0.426	0.001*	-0.378	0.003*
Hypertension	**Yes**	0.516	< 0.001*	-0.210	0.016*
	No	0.429	0.001*	-0.359	0.005*
Smoking	**Yes**	0.402	0.001*	-0.195	0.103
	No	0.546	< 0.001*	-0.294	0.001*

*Significant

DISCUSSION

The present study explored the connection between RRI, S.creatinine levels, and albuminuria in patients with diabetic nephropathy. Our findings revealed a significant positive correlation between RRI and serum creatinine, and a moderate to strong association between RRI and the degree of albuminuria. These results are in alignment with existing literature and further substantiate the role of RRI as a non-invasive marker of renal vascular resistance and progression of diabetic nephropathy.

Numerous investigations have explained that RRI increases with declining renal function, as reflected by raised serum creatinine levels and lower (estimated glomerular filtration rate) eGFR. In a study by Radermacher et al., RRI was found to predict long-term renal outcomes in patients with renal artery stenosis, suggesting its utility in various renal pathologies beyond structural damage alone[14]. Similarly, Sugiura and Wada reported a positive correlation between RRI and serum creatinine in patients with chronic kidney disease, including those with diabetic nephropathy[15].

Albuminuria, an early marker of glomerular damage in diabetes, also showed a significant correlation with elevated RRI in our study. This is consistent with the findings of Nosadini et al., who demonstrated that patients with micro- and macroalbuminuria had significantly higher RRI values compared to normoalbuminuric diabetic patients [16]. This suggests that vascular changes, such as arteriolosclerosis and increased intrarenal vascular resistance, may precede or accompany glomerular injury in diabetic nephropathy.

Furthermore, the elevation of RRI in diabetic patients may reflect both structural and functional changes in renal microvasculature, including thickening of the basement membrane, mesangial expansion, and interstitial fibrosis. These pathophysiological alterations contribute to increased vascular stiffness and reduced compliance, which are reflected in Doppler-derived RRI measurements [17]. Therefore, monitoring RRI may provide insights into both hemodynamic and structural changes in diabetic kidneys.

Importantly, RRI is influenced by multiple systemic factors such as age, blood pressure, and vascular compliance, which should be considered when interpreting values. However, when used alongside traditional biomarkers like serum creatinine and albuminuria, RRI can offer complementary information regarding renal health and disease progression [18].

Limitations:

Small sample size, low budget, time constrain, and ethical barriers are the limitations of this research. More work can be done.

CONCLUSION:

It is concluded; our study supports the use of RRI as a valuable, non-invasive marker that correlates well with serum creatinine and albuminuria in diabetic nephropathy. Its incorporation into routine clinical assessments could aid in early detection and risk stratification of renal impairment in diabetic patients. Further longitudinal studies are needed to determine its prognostic value in predicting renal outcomes.

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AUTHOR CONTRIBUTION

Author	Contribution
Nazish Fatima*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Huma Hameed	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Yasser Khan	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Sadia Tahir	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Hina Rehman	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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