Correlation Between Resistive Index and Serum Creatinine in Patients with Diabetic Nephropathy

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ABSTRACT

Objective: To evaluate the renal resistive index (RI) and serum creatinine correlation in patients with diabetic nephropathy.
Study Design: Cross-sectional study
Place and Duration of Study: Department of Radiology, Pakistan Institute of Medical Sciences, Islamabad Pakistan, from Nov 2020 to Apr 2021.
Methodology: This study was conducted on 80 patients. Doppler renal artery sonography was carried out, and for all the individuals with controlled blood pressure, gender, age, urinary protein, serum creatinine and HBA1c were recorded.
Results: In our study, 42(52%) patients were females, whereas the remaining 38(48%) were males. The mean age was observed to be 49.15±11.91 years. A significant positive correlation (r=0.53) was found between Resistive Index and Serum Creatinine. The correlation co-efficient values between Resistive Index and Serum Creatinine in female and male patients were r=0.58 and r=0.47, respectively.
Conclusion: The present study concluded that RI had no significant statistical correlation with albuminuria, proteinuria and HbA1c levels. However, a statistical correlation between RI and creatinine level was reported.

Keywords: Creatinine, Diabetic Nephropathy, Resistive index(RI).

INTRODUCTION

Diabetes mellitus is a leading socio-economic and prime health issue in the modern era. According to various studies, approximately 3/4th of the population will be diagnosed with diabetes by 2025.[1,2] Renal complication being the most critical complication of diabetes, follows various stages. It is estimated that individuals with type 2 diabetes have approximately 25% to 30% chances of developing nephropathy. Diabetic mellitus type 1 and 2 have similar incidence.[3] However, studies indicate that nephropathy incidence increases rapidly in type 2 diabetes.[4] Terminal stages of renal failure are mostly caused by diabetic nephropathy in the Western world.[5] End-Stage Renal Disease (ESRD) is associated with diabetic nephropathy with a prevalence of 15 to 40%.[6] The diabetic nephropathy outcome leads to either normal recovery or ERSD.[7] In the USA, about 30-40% of ERSD is caused by diabetic nephropathy.

Hyperglycemia could lead to chronic diabetes complications, which might include nephropathy, as reported by many researchers.[8] Advanced stage nephropathy can be detected in diabetic nephropathy early stage by a good factor; micro-albuminuria. It also diagnoses kidney disease as an initial diagnostic sign. Type 2 diabetes patients' renal function outcomes can be determined by a non-invasive diagnostic technique, also known as a resistive index (RI). Microalbuminuria in diagnosed type 2 diabetes patients could be detected early by increased resistive index and renal artery resistance. Renal blood flow can be changed with resistive index and renal impairment, which strongly correlate with serum creatinine levels.[9]

Although various studies investigated the correlation between renal resistive index (RI), proteinuria, and renal dysfunction, few studies focused on the association and correlation between serum creatinine and renal resistive index (RI).[9,10] Therefore, this study aimed to evaluate the significance of the renal resistive index (RI) as a non-invasive marker of renal damage and the effect of serum creatinine levels on the renal resistive index (RI). It is useful in making diagnostic decisions in the clinical care of diabetic nephropathy patients.

METHODOLOGY

The cross-sectional study was conducted on 80 patients from November 2020 to April and 2021 at the Pakistan Institute of Medical Sciences Hospital, Islamabad, Pakistan after ethical approval (No. F. 1-1/2015/ERB/SABMU/766) from the Institutional Ethical Committee. The sample size was calculated

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from the website of UCSF Clinical and Translational Science Institute (https://sample-size.net/correlation-sample-size/), taking the correlation coefficient (r) between RI and Creatinine -0.5710.

Inclusion Criteria: Patients of either gender, aged 21-64 years, having type 2 diabetes mellitus attending follow-ups were included in the study.

Exclusion Criteria: Patients with diseases such as muscular dystrophy, dehydration, glomerulonephritis, pyelonephritis, eclampsia and preeclampsia, and rhabdomyolysis with higher than normal plasma creatinine were excluded from the study. In addition, the patients with renal artery stenosis, hydronephrosis, and certain drugs that may affect the test were excluded from the study. These drugs include Aminoglycosides, Cimetidine, heavy metal chemotherapy drugs (e.g. Cisplatin) and nephrotoxic drugs (e.g. Cefoxitin).

All the individuals underwent Doppler ultrasound to evaluate bilateral renal arteries using a curvilinear 2-5 MHz probe on Aplio 500 (Toshiba). The resistive index (RI) was taken as an average resistive index of renal arteries, including interlobar and segmental branches. All the individuals with controlled blood pressure, gender, and age, with necessary blood and urine tests for determination of proteinuria, albuminuria, creatinine level and HBA1c meeting up the inclusion criteria, were enrolled. In contrast, patients lacking the above criteria were excluded. Data collection was done with a non-probability consecutive sampling technique. Written informed consent was taken in writing from all the individuals, and the aim of the study was explained to the participant.

The data were analyzed by Statistical Package for Social Sciences (SPSS) version 24:00. Quantitative variables were expressed as mean±SD and qualitative variables were expressed as frequency and percentages. The rank correlation was used to determine the linear bivariate correlation between RI and creatinine.

RESULTS

Of the 80 patients, 42(52%) were females, and 38(48%) were males. The mean age of the patients was 49.15±11.91 years, with minimum and maximum ages recorded as 21 and 64 years, respectively (Table-I). We applied rank correlation, and the results are mentioned in Table-II. The rank correlation between Resistive Index (RI) and Serum Creatinine level was 'r'0.53 with a p-value <0.001. This positive correlation pattern was highlighted through the case-to-case variation of both variables through a line chart (Figure-1).

Table-I: Descriptive Statistics (n=80)

Variables	Minimum	Maximum	Mean±SD
Albuminuria (g/dL)	134.7	169.5	153.43±9.67
Proteinuria (mg/dL)	138.7	181.3	157.66±11.03
HbA1c (%)	6.87	8.88	7.95±0.44
RI	0.49	0.73	0.65±0.05
Creatinine level (mg/dL)	0.5	1.30	0.86±0.18

Table-II: Rank correlation between Lab Parameters (n=80)

Variables	Albuminuria	Proteinuria	HbA1c	RI	Creatinine Level
Albuminuria	1	0.075	-0.87	-0.24	-0.013
Proteinuria		1	-0.229	0.02	-0.191
HbA1c			1	-0.51	0.226
Resistive Index				1	0.53
Creatinine level					1

The variation of creatinine was also seen against RI through the line chart, showing the same positive relationship between them. (Figure-2). It is also observed that a negative correlation between HbA1c and proteinuria correlation coefficient 'r' -0.229 with p value 0.041, whereas a positive correlation was found between HbA1c and Serum creatinine correlation coefficient 'r' 0.226 with *p*-value 0.044.
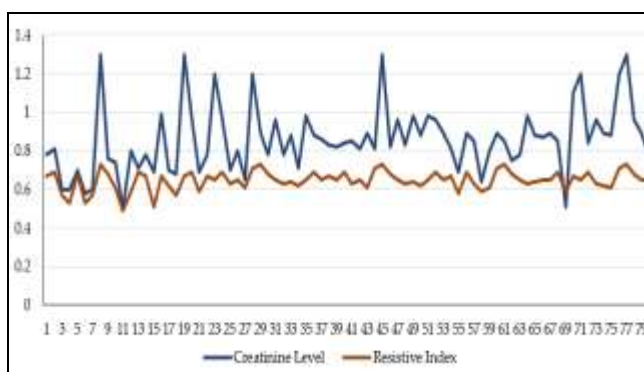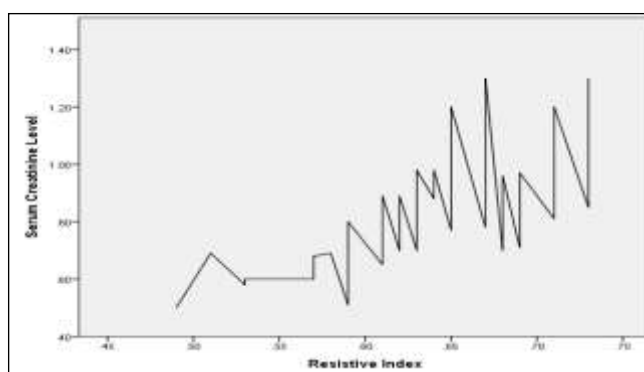

Figure-1: Line chart of RI and Creatinine (n=80)

Figure-2: Correlation Pattern Between Renal Resistive Index and Serum Creatinine (n=80)

DISCUSSION

The diabetic patient's vascular complication is diabetes nephropathy. The disease onset might cause structural and functional disorders. Doppler sonography is the simplest imaging module for the hemodynamics examination of the kidney. The grounds for the rise in the resistive index (RI) and fall in kidney glomerular function in diabetic patients are still unknown. Blood flow and resistive index (RI) increased by glomerular sclerosis and interstitial fibrosis respectively. [11,12]

This study focused on patients with diabetic nephropathy and its association with resistive index (RI), proteinuria, albuminuria and creatinine levels. About Eighty patients with diabetes were examined for renal artery Doppler ultrasonography. The result showed a significant positive correlation between Resistive Index and Serum Creatinine (r=0.53). Post-stratification correlation between Resistive Index and Serum Creatinine in female and male patients was 0.58 and 0.47, respectively. Albuminuria, proteinuria, and resistive index (RI) had an insignificant association. The resistive index (RI) increased with an increase in creatinine levels. Genov D et al. in 2018 reported a positive correlation between RI and serum creatinine (r =0.418; p=0.001) in patients with diabetic nephropathy, which shows consistency with our results .[13,14] Miyoshi et al. reported a significant association between serum level and resistive index (RI), while the resistive index (RI) reveals diabetic nephropathy clinical diagnosis an advance as a prognosticator.[15] Hamano et al. reported that All patients in their study with RI ≥0.68 had significantly higher serum creatinine and lower creatinine clearance compared with patients with RI <0.68, consistent with the results of our study.[16] Higher incidence of the male population had resistive index (RI) more correlated to serum creatinine levels in our study. It can be justified because male patients have a higher prevalence of diabetic mellitus.[17,18]

The present study aimed to introduce the clinical significance of renal resistive index (RI) to enable physicians to include renal Doppler in the routine nephrological workup of patients as it provides reliable estimation of renal function even in challenging clinical settings where renal function assessment by serum creatinine is doubtful.

LIMITATIONS OF STUDY

Firstly, it was a single-centre observational study with a diversified population, restricting its possibility for external validation. Secondly, diligent exclusion criteria were used to properly control preliminary analytical disparity for a sturdy analysis of the renal resistive index (RI). Any selection bias may have arisen in the inclusion of patients, which could arbitrate the reliability of our data analysis. Thirdly, we did not consider intra-abdominal pressure in all patients; intra-abdominal pressure has a known effect on the renal resistive index (RI). Finally, a single operator performed all renal resistive index (RI) parameters. The concerned person had a good knowledge of the technique. However, we did not conduct a blinded control of a random sample to ascertain reliability.

CONCLUSION

The present study concluded that resistive index (RI) had no significant correlation with albuminuria, proteinuria or HbA1c levels. However, a statistical correlation was reported between resistive index (RI) and serum creatinine level. Henceforth, doppler examination may provide physicians with an extra window of opportunity for evaluating renal dysfunction in patients with diabetic nephropathy and therefore provide a reliable estimation of renal function even in difficult circumstances where renal function assessment by serum creatinine is doubtful.

Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

AK & AA: Data acquisition, critical review, approval of the final version to be published.
MRB & IZ: Data analysis, data interpretation, critical review, approval of the final version to be published.
MNNK & JE: Conception, study design, drafting the manuscript, approval of the final version to be published.
Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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