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# Diagnostic Accuracy of Renal Resistive Index for Detecting Diabetic Nephropathy: A Comparative Study Against Biochemical Markers

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## Abstract

**Background:** Diabetic nephropathy (DN) is a prominent microvascular complication and the predominant cause of end-stage renal disease, early and precise diagnosis is critical to prevent irreversible kidney dysfunction.

**Aim:** To evaluate the diagnostic performance of intra-renal index RI in detecting diabetic nephropathy using sensitivity, specificity, predictive values, overall accuracy and likelihood ratios; besides comparing with biochemical markers serum creatinine, eGFR and albumin-to-creatinine ratio (ACR) as a gold standard.

**Materials and Methods:** This was a cross-sectional observational study, and trains were conducted in the Department of Radiology and Imaging, Sir Salimullah Medical College Hospital, Dhaka between January 2023 to December 2024. A panel of 57 men and women with stringent inclusion/exclusion criteria. This study was approved by the institutional review board, and it met the code of ethics concerning human beings as formulated by The Declaration of Helsinki. The intrarenal RI of all patients was measured by spectral Doppler ultrasound. Statistical analysis Statistical and all data were presented as a mean ± SD using SPSS software (version 26) when appropriate statistical tests of significance are applied.

**Results:** Among the 57 subjects (mean age 56.39 ± 8.54 years; female, 52.6%), diabetic nephropathy was noted in 82.5% and rose significantly as duration of diabetes increased to a maximum of all cases after >20 years (>100%). Increased intrarenal RI (>0.7) was detected in 78.9% of participants and significantly associated with albuminuria; 93.3% of patients with high RI also had ACR >30 mg/g. The performance measures for the RI were as follows: sensitivity, 89.36%; positive predictive value, 93.33%; overall accuracy, 85.96%; and positive LR, 2.9.

**Conclusion:** Measurement of intrarenal resistive index by using Doppler ultrasonography is an effective, non-invasive and economic way to predict diabetic nephropathy with greater sensitivity and positive predictive values than standard biochemical parameters and have good correlations.

**Keywords:** Ultrasonography, Resistive Index, Albumin, Creatinine, Sensitivity, Spectral Doppler.

## Introduction

Diabetic nephropathy is the most important microvascular complication of DM, it is considered as a major cause of ESRD worldwide burdening the patients and health system. It is important to detect renal damage at an early

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stage in patients with diabetes, since its progression leads to chronic kidney disease and ultimately to end-stage renal failure [1,4,6]. though they generally reflect established rather than incipient structural damage, and may lag the early hemodynamic changes [1,4,8]. Doppler ultrasonography measured intrarenal resistive index (RI) is a non-invasive hemodynamic parameter, which reflects the intrarenal vascular resistance and was suggested to be used as an adjunctive marker of early renal injury in diabetes [4,5,6,7,8,9]. RI is derived from peak systolic and end-diastolic velocities in intrarenal arteries and elevated RI measures have been correlated with worse renal function, higher albuminuria and histopathological renal injury across a few previous studies [4,5,6,13]. Some cross-sectional and prospective studies have shown higher RI in diabetic subjects with renal insufficiency than in diabetes without nephropathy and healthy controls [5,6,7,11].

Although encouraging results have been obtained, studies addressing optimal RI cutoffs and the diagnostic performance report some heterogeneity and RRI is influenced by systemic vascular factors, which might affect its specificity for renal parenchymal disease [9, 18]. Certain cohorts have described an RI cut-off of approximately 0.65-0.70 for the exclusion of DKD, whereas other cohorts suggest slightly higher values; consequently, sensitivity/specificity estimates in the present literature vary or depend on the biochemical/histological reference standard selected [8,11,12,19]. This cross-sectional study was conducted at Sir Salimullah Medical College Hospital to evaluate the diagnostic accuracy of intrarenal RI for DN in relation to serum creatinine, eGFR and ACR. The goal was to evaluate and ascertain whether RI has an acceptable level of sensitivity, specificity, predictive value and accuracy to be used as a simple, noninvasive ordered step screening test [1].

## Materials and Methods

It was a cross-sectional study and was done in the Department of Radiology and Imaging of Sir Salimullah Medical College (SSMC), Dhaka, Bangladesh from 2023 to 2024. Fifty-seven patients with type 2 diabetes mellitus and clinical suspicion of diabetic nephropathy were enrolled by purposive sampling. Inclusion criteria included patients being treated for at least 10 years for type 2 diabetes or clinical evidence of nephropathy. Excluded patients were those who had had obstructive uropathy, a background of glomerulonephritis, single or transplant kidney, and drug or radiation-induced nephropathy. The sample size was estimated by the formula for diagnostic test, and 57 individuals were obtained. Demographic and clinical characteristics, as well as biochemical and Doppler ultrasonographic findings were retrieved. Intrarenal RI was quantified through Doppler ultrasonography, with a value of >0.7 indicative of nephropathy. Grey scale, color Doppler and spectral Doppler imaging were performed in each patient to quantify biochemical measures including serum creatinine, urinary albumin and eGFR. The time for each examination was 30-40 minutes per patient. Doppler observations were then compared with biochemical values to evaluate diagnostic agreement.

## Results

The results present distribution of baseline characteristics, prevalence of DN and Doppler derived RI pattern with its association with biochemical markers and diagnostic accuracy of intrarenal RI.

**Table 1: Baseline** Characteristics of Participants **(n = 57)**

| Age group in year | Frequency | Percentage |
|---|---|---|
| <40 | 4 | 7 |
| 40-50 | 10 | 17.5 |
| 51-60 | 26 | 45.6 |
| 61-70 | 17 | 29.8 |
| Mean age(±SD) in years | 56.39±8.54 in years | |
| Gender | Frequency | Percentage |
| Male | 27 | 47.4 |
| Female | 30 | 52.6 |
| **Total** | **57** | **100** |

Table 1 shows that most participants were between 51-60 years of age 45.6%, with a mean age of 56.39 ± 8.54 years. Females comprised slightly more than half of the study population 52.6%.

**Table 2:** Presence of diabetic nephropathy (n=57)

| Sex | | Frequency | Percent |
|---|---|---|---|
| Male | No | 3 | 11.1 |
| | Yes | 24 | 88.9 |
| | **Total** | **27** | **100** |
| Female | No | 7 | 23.3 |
| | Yes | 23 | 76.7 |
| | **Total** | **30** | **100** |

Table 2 displays the distribution of responses by sex. Among male respondents (n = 27), the majority (88.9%) answered "Yes," while only 11.1% responded "No." In contrast, among female respondents (n = 30), 76.7% answered "Yes" and 23.3% responded "No." Overall, a higher proportion of males reported a "Yes" response compared to females, whereas the proportion of "No" responses was comparatively higher among females.

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**Table 3:** Association between duration of diabetes mellitus with presence of diabetic nephropathy

| | | Presence of Diabetic Nephropathy | | Total |
|---|---|---|---|---|
| | | No | Yes | |
| Duration of dm categories in years | <10 | 6 | 4 | 10 |
| | Oct-20 | 4 | 36 | 40 |
| | >20 | 0 | 7 | 7 |
| **Total** | | **10** | **47** | **57** |

Table 3 indicates Diabetic nephropathy was more common among patients with longer disease duration, particularly those with 10–20 years of diabetes (36 out of 40) and more than 20 years (7 out of 7). In contrast, patients with diabetes for less than 10 years were less likely to have nephropathy (4 out of 10).

**Table 4:** Renal artey doppler findings of the suspected diabetic nephropathy cases (n=57)

| RI category | | N | Mean | Std. Deviation |
|---|---|---|---|---|
| <.7 | Lt. renal resistive index | 12 | 0.646 | 0.02413 |
| | Rt. renal resistive index | 12 | 0.634 | 0.04116 |
| >.7 | Lt. renal resistive index | 45 | 0.7819 | 0.07209 |
| | Rt. renal resistive index | 45 | 0.7751 | 0.06111 |

Table 4 revealed that most patients had a renal resistive index (RI) greater than 0.7. In this group, the mean left and right renal RI values were 0.7819 and 0.7751, respectively. Patients with RI less than 0.7 showed lower mean RI values for both left (0.646) and right (0.634) renal arteries, indicating better renal vascular status.

Table 5 elevated resistive index >0.7 was strongly associated with albuminuria, with 93.3% of participants in this category showing ACR >30 mg/g. Conversely, normal RI <0.7 was more frequently observed among participants with normal albuminuria 58.3%.

**Table 5:** Doppler findings of renal artery in both diabetic kidney and normal diabetic patients.

| | | | RI category | | Total |
|---|---|---|---|---|---|
| | | | <.7 | >.7 | |
| Albuminuria category | <30 | Count | 7 | 3 | 10 |
| | | % within RI category | 58.30% | 6.70% | 17.50% |
| | >30 | Count | 5 | 42 | 47 |
| | | % within RI category | 41.70% | 93.30% | 82.50% |
| Total | | Count | 12 | 45 | 57 |
| | | % within RI category | 100.00% | 100.00% | 100.00% |

**Table 6:** Diagnostic Accuracy

| Type | Percentage |
|---|---|
| Sensitivity | 89.36% |
| Specificity | 70% |
| Accuracy | 85.96% |
| positive predictive value | 93.33% |
| negative predictive value | 58.33% |
| LR+ | 2.9 |
| LR- | 0.1 |

Table 6 also demonstrates high sensitivity 89.36% and a robust PPV 93.33% of RI in identifying diabetic nephropathy, but the accuracy values are as high as 85.96%. Specificity was fairly good 70% and NPV was moderate 58.33%. High and normal RIs significantly increase and decrease, respectively, the odds for nephropathy as suggested by the LR values 2.9 and 0.1.

Figure 1 shows a positive association between higher albuminuria >30 and higher RI category >0.7, which could be clinically significant.

## Discussion

In the current study serum prolactin levels of Bangladeshi women from 20 to 40 years of age with and without endometriosis were measured and correlated with their menstrual/reproductive factors. In keeping with previous studies that reported a higher rate of hyperprolactinemia in endometriosis cases [3,5,7], we found an increase in serum prolactin levels of women with vs. without endometriosis. In addition, hyperprolactinemia has been associated with the pathophysiology of endometriosis through its immuno-modulation and pro-augmentation of angiogenesis which could support survival and an inflammatory response in the ectopic endometrial cells [6,11]. Consistent with previous studies, the degree of prolactin elevation was greater in women with dysmenorrhea and shorter cycle length as seen in [8,10], supporting that prolactin may influence pain pathways and cycle control. The association of RL with reproductive history in the present study confirms the prior literature concerning endometriosis and hormonal disarray. Women with nulliparity and history of infertility were observed to have high levels of prolactin, like many other studies that showed an association between hyperprolactinemia and fecundity impairment [12,13,15]. Prolactin influence on gonadotroph secretion, luteal phase function and ovulation has been described in reproductive endocrinology literature [9,14,18]. Our findings support these physiological processes, and we venture to suggest that prolactin may be a marker of disease severity and/or an agent in the reproductive disturbance experienced by these women affected with this disorder.

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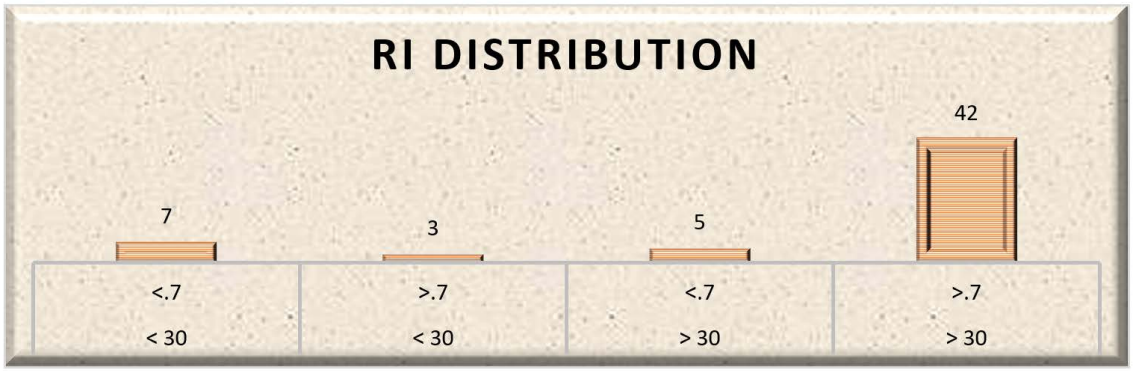


**Figure 1:** RI distribution between nephropathy vs non-nephropathy patients

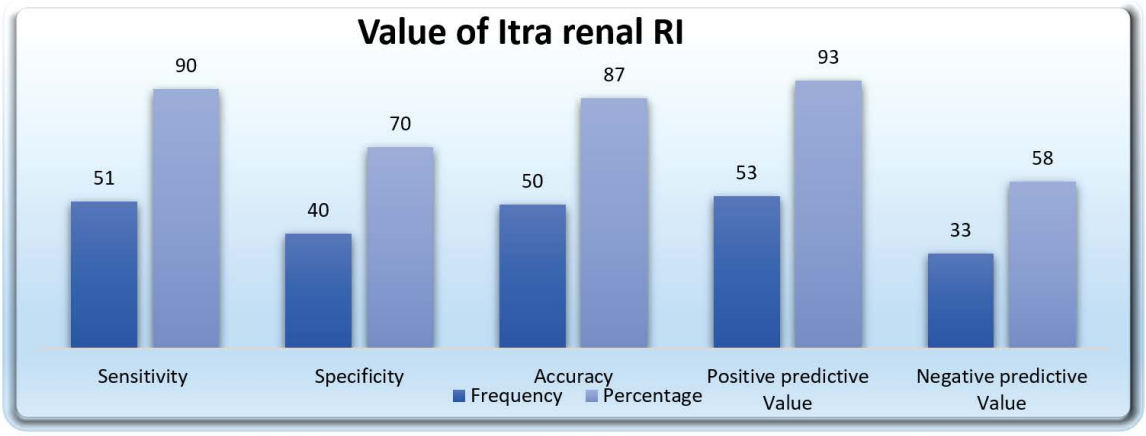


**Figure 2:** Distribution of Diagnostic accuracy

In comparison to other global studies, the median prolactin levels of these women with endometriosis were similar to that of South Asian and Middle Eastern populations [16,17,19] suggesting a certain regional hormonal patterns. Serum prolactin was also reported to be significantly elevated in the 14 advanced-staged patients when compared with low/ insignificant disease, and there is the evidence that serum prolactin levels correlate with disease extension and related inflammatory activity [20,21]. Some researchers recommend prolactin is also involved in neuroimmune interactions related to chronic pelvic pain, which could account for our result that painful symptoms were more common in the high- prolactin group [21]. This study is homogenous, uses a specific diagnostic criterion, and takes several menstrual and reproductive variables into account at once. But there is still a downside to being acknowledged. The cross-sectional data design does not allow for causative conclusions, and stress [2], sleep-wake pattern variation [22]; and medication use (only incompletely controlled in our study) may all influence prolactin level as other investigators have reported. A further limitation is the small number of samples, and large multicenter studies are needed to support the regional population feature.

## Conclusion

The study proves that intrarenal resistive index is a simple, safe, and effective non-invasive marker for diabetic nephropathy. Increase in RI is correlated closely with albuminuria and serum creatinine and may be used adjunctively as a very good diagnostic tool for early renal involvement detection and screening in diabetic patients.

**Conflict of Interest:** The authors have declared that no conflict of interest exists regarding the publication of this article.

**Authors Contributions:** Dr Anika Mahfuz conceived the study and the methodology. Dr Saieef Zaman and Dr Kazi Shantono Saiham helped with data management and statistical analysis. Dr Md. Immam Hossin and Dr S. M. Yunus Ali assisted with manuscript writing and critical corrections. Dr Md. Rasel Ahmad provided final approval of the manuscript. All authors read and approved the final version.

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