

# Correlation of Duplex Ultrasound and Biochemical Parameters in Diabetic Nephropathy: A Narrative Review

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## ABSTRACT

Diabetic nephropathy (DN) is a chronic microvascular complication of diabetic mellitus. Progressive loss of kidney function can lead to end-stage renal disease (ESRD). Diabetic nephropathy can be detected and managed early, which can help to prevent or postpone the development of ESRD. Duplex ultrasound can be used to quantify renal characteristics such as length, echogenicity, parenchymal thickness, and resistive index (RI), which could help in the early diagnosis of DN. The purpose of this article was to study the correlation of duplex ultrasound findings and biochemical parameters in diabetic nephropathic patients. A progressive increase in the renal RI, derangement of renal sonomorphological parameters, and biochemical parameters were found with advancing DN. Similar studies have shown this relationship which can be used for early detection of DN which helps to reduce morbidity to great extent.

**Keywords:** Diabetic nephropathy, Doppler, Renal ultrasound.

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## INTRODUCTION

Diabetic kidney disease or DN is a chronic microvascular complication of diabetic mellitus. Progressive loss of kidney function, albuminuria leading to ESRD requires frequent dialysis and kidney transplantation. Diabetic nephropathy can be detected early, which can help to prevent ESRD. Micro-albuminuria and estimated glomerular filtration rate (eGFR), kidney function tests were the mainstay of diagnosis. Derangement of GFR, blood urea, and creatinine occur only after the loss of nearly half of functional renal tissue. Ultrasonography is a safe and noninvasive tool to evaluate renal sonomorphological characteristics and renal RI. It has been proposed as a new parameter that is useful in the early and accurate diagnosis of DN. This review article aims at studying the correlation of duplex ultrasound and biochemical parameters in the diagnosis of DN.

## Correlation of Duplex Ultrasound and Biochemical Parameters in Diabetic Nephropathy

Diabetes mellitus (DM) is a metabolic condition caused by decreased insulin production, insulin action, or both. It is characterized by chronic hyperglycemia with disturbances in carbohydrate, protein, and lipid metabolism. Diabetes mellitus causes long-term damage, malfunction, and failure of many organs.<sup>1</sup> Chronic hyperglycemia, in combination with other metabolic abnormalities, can mutilate various organ systems, resulting in incapacitating and life-threatening health complications, the most prominent of which are microvascular (retinopathy, nephropathy, and neuropathy) and macrovascular complications, which increase the risk of cardiovascular disease.

Type 2 diabetes is prevalent in individuals of all ages and ethnicities, and it is increasing at an alarming rate. Importantly, the public health burden of type 2 diabetes may be underestimated because 33 and 50% of people with type 2 diabetes (about 8 million) go misdiagnosed and untreated.<sup>2,3</sup>

Elevated blood pressure, microalbuminuria, and proteinuria are all symptoms that DN is progressing.<sup>4-6</sup> Microalbuminuria, or low and abnormal levels of albumin in the urine, is the early clinical

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sign of nephropathy. Proteinuria is noted in the later stages of the disease.<sup>7</sup>

Ultrasonography is a first-line imaging method. It is mostly used to rule out urological diseases, discriminate between acute and chronic renal failure, track the progression of a disease, and guide needle biopsy, among other things. Characterizing the pelvis, analyzing renal morphology, color-power Doppler signals, and quantifying renal RI are all possible with ultrasound imaging.<sup>8</sup>

This article reviews the role of ultrasound as an effective parameter for early detection of DN which can help in reducing the perinatal mortality in a largely resource-poor setting like rural India.

Samar et al.<sup>9</sup> found that the advancement of DN leads to a rise in renal RI values. A positive correlation between RI values and albuminuria and serum creatinine was discovered, and this correlation was statistically significant. They came to the conclusion that intrarenal RI can be used to diagnose DN and track its progression.

Gopalakrishnan et al.<sup>10</sup> found that in diabetic renal disease, renal length and parenchymal thickness are unreliable predictors of

disease severity. The intra-renal RI and renal echogenicity correlate well with most biochemical indicators, implying that this Doppler index has a supplementary role in diabetic renal illness.

Ahmed et al.<sup>11</sup> found that serum creatinine and cortical echogenicity grading had a good correlation ( $r = 0.915$ ;  $p = 0.0005$ ). In comparison to longitudinal length, parenchymal thickness, and cortical thickness, renal cortical echogenicity is the best sonographic metric that corresponds with serum creatinine and its grading in patients with chronic kidney disease (CKD).

Maksoud et al.<sup>12</sup> did a study to assess the role of the renal RI in detecting functional abnormalities in renal hemodynamics in patients with type 1 diabetes using renal Doppler. Increased disease duration of more than 10 years, elevated serum HbA1c of more than 7.5%, and early pubertal stages were all related to a progressive increase in RI. They concluded that renal RI could be a valuable supplemental test for assessing changes in renal hemodynamics in DN in its early stages.

Shaw et al.<sup>13</sup> in order to analyze diabetic nephropathy, looked at biochemical parameters, sonomorphological findings, and Doppler ultrasonography data, as well as the association between them. Renal sonomorphological abnormalities were seen in a small number of patients, and only in the most advanced stages of diabetic nephropathy, while RI values were higher in the majority of patients in subgroups 2, 3, and 4, and even in those with normal sonomorphological features. The values of RI had a favorable correlation with biochemical parameters, implying that Doppler ultrasound has a supplementary role in diabetic nephropathy.

Sidappa et al.<sup>14</sup> did a study to assess the importance of renal echogenicity in diagnosing the course of CKD and sonographic grading of CKD, researchers correlated renal echogenicity with serum creatinine. Cortical echogenicity was graded based on imaging. There was a statistically significant positive connection between serum creatinine and cortical echogenicity grading ( $p = 0.004$ ).

Mancini et al.<sup>15</sup> did a study where duplex sonography was used to determine the renal volume and intrarenal hemodynamics. When compared to the controls, the diabetic patients' renal volume and RI values were significantly larger. Even in diabetic patients who did not have proteinuria, renal hypertrophy was seen. Proteinuria was considerably higher in those with a higher RI score. These findings suggest that duplex sonography could be useful in detecting morphologic and hemodynamic abnormalities in the kidneys of type 2 diabetic individuals.

Sperandeo et al.<sup>16</sup> found that the pulsatile index (PI) and RI were higher in patients with microalbuminuria than in controls, implying that duplex Doppler sonography is a complementary diagnostic test for diabetic nephropathy.

Casadei et al.<sup>17</sup> determined that RI help in the early detection of patients affected by non-insulin-dependent diabetes mellitus (NIDDM) showing renal vascular involvement without any other alterations of the traditional ultrasound parameters.

Soldo et al.<sup>6</sup> did a study to compare conventional and duplex ultrasonography in the diagnosis of diabetic renal disease and to check the correlation between increased renal vascular resistance and mild renal functional impairment in asymptomatic patients. They came to the conclusion that conventional ultrasound can only detect kidney abnormalities in diabetes individuals in the extremely advanced stages of the disease. Pathologic RI, on the

contrary, can be recognized early on. The levels of serum creatinine and the rate of creatinine clearance correlate with RI.

## CONCLUSION

When compared to biochemical data, renal ultrasound and Doppler is a good diagnostic tool in the early diagnosis of diabetic kidney disease. Even if biochemical parameters show subtle changes, decrease in renal length and parenchymal thickness, as well as an increase in renal RI, with the progression of diabetic nephropathy, is diagnostic for significant renal involvement.

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