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Original Research Article

Serum Vaspin Levels as a Biomarker of Insulin Resistance and Diabetic Complications in Type 2 Diabetes Mellitus: A Comparative Cross-Sectional Study

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Conflict of interest: Nil

Abstract

Background: Type 2 diabetes mellitus (T2DM) is a major global health challenge associated with insulin resistance, obesity, and microvascular and macrovascular complications. Vaspin (Visceral Adipose Tissue-Derived Serine Protease Inhibitor) is an adipokine implicated in glucose homeostasis and insulin sensitivity. Its role as a biomarker for diabetic complications remains incompletely understood.

Aim: To estimate serum vaspin levels in patients with T2DM and evaluate its association with obesity, glycemic status, lipid profile, and diabetic complications.

Materials and Methods: A hospital-based comparative cross-sectional study was conducted among 50 participants. Twenty-five patients with T2DM and established complications were compared with 25 T2DM patients without complications. Anthropometric parameters, fasting blood sugar (FBS), postprandial blood sugar (PPBS), glycated hemoglobin (HbA1c), lipid profile, renal function parameters, microalbuminuria, and serum vaspin levels were assessed. Statistical analysis was performed using appropriate parametric tests, and correlations were determined.

Results: Patients with diabetic complications demonstrated significantly lower serum vaspin levels compared with those without complications. Serum vaspin exhibited significant negative correlations with BMI, FBS, PPBS, and HbA1c. Triglycerides, LDL cholesterol, urea, creatinine, and microalbuminuria were significantly higher in patients with complications. Reduced serum vaspin levels were associated with increased risk of diabetic complications.

Conclusion: Serum vaspin levels are significantly reduced in T2DM patients with complications and correlate with markers of insulin resistance and metabolic dysfunction. Vaspin may serve as a promising biomarker for early identification and monitoring of diabetic complications.

Keywords: Type 2 diabetes mellitus; Vaspin; Insulin resistance; Adipokines; Diabetic complications; Biomarkers.

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Introduction

Type 2 diabetes mellitus (T2DM) is one of the most prevalent metabolic disorders worldwide and represents a significant public health burden [1]. The disease is characterized by chronic hyperglycemia resulting from impaired insulin secretion, insulin resistance, or both [2].

The global rise in obesity and sedentary lifestyles has accelerated the prevalence of T2DM, particularly in developing countries such as India [3]. Insulin resistance plays a central role in the pathogenesis of T2DM and contributes substantially to the development of vascular complications [4]. Visceral adiposity has emerged as a key determinant of insulin resistance due to its endocrine activity and secretion of numerous adipokines involved in metabolic regulation [5].

Vaspin (Visceral Adipose Tissue-Derived Serine Protease Inhibitor), also known as SERPINA12, is a member of the serine protease inhibitor family initially identified in visceral adipose tissue of

Otsuka Long-Evans Tokushima Fatty rats[6]. Vaspin has attracted considerable interest because of its insulin-sensitizing, anti-inflammatory, and anti-atherogenic properties [7]. Experimental evidence suggests that vaspin may improve insulin sensitivity through inhibition of kallikrein-7 and modulation of inflammatory pathways [8].

Recent investigations have indicated that circulating vaspin concentrations may be associated with obesity, insulin resistance, glucose metabolism, and cardiovascular risk [8]. However, the relationship between serum vaspin levels and diabetic complications remains controversial, with studies reporting variable findings [9].

Understanding the association between serum vaspin levels and diabetic complications may provide valuable insights into disease progression and facilitate the identification of novel biomarkers for early intervention [10]. Therefore, the present study was undertaken to evaluate serum vaspin levels in patients with T2DM with and without complications and to determine their relationship with metabolic parameters and insulin resistance.

Objectives

Primary Objective: To estimate serum vaspin levels among patients with Type 2 Diabetes Mellitus.

Secondary Objectives

1. To compare serum vaspin levels between T2DM patients with and without complications.
2. To evaluate the association between serum vaspin levels and obesity.
3. To correlate serum vaspin levels with glycemic indices.
4. To assess the relationship between serum vaspin levels and lipid profile parameters.
5. To determine the potential role of vaspin as a biomarker of diabetic complications.

Materials and Methods

This comparative cross-sectional study was conducted over a period of one year in the Department of General Medicine of a tertiary care teaching hospital. The study population comprised patients diagnosed with Type 2 Diabetes Mellitus (T2DM) who attended the outpatient and inpatient services of the hospital during the study period. A total of 50 participants were enrolled and categorized into two groups.

Group I consisted of 25 patients with T2DM and documented diabetic complications, while Group II included 25 patients with T2DM without any evidence of diabetic complications. Eligible participants were recruited after obtaining written informed consent. Detailed demographic, clinical, anthropometric, and laboratory data were collected using a structured proforma. The study aimed to compare serum vaspin levels and their association with glycemic status, obesity, renal function, lipid profile, and diabetic complications between the two groups.

Study Participants and Data Collection: Patients with Type 2 Diabetes Mellitus (T2DM) aged above 30 years who were willing to participate in the study were recruited. The study group consisted of patients with documented microvascular or macrovascular diabetic complications, whereas the comparison group included T2DM patients without any evidence of complications. Patients with Type 1 diabetes mellitus, gestational diabetes mellitus, acute infections, chronic inflammatory disorders, malignancy, severe hepatic disease, and pregnant women were excluded from the study.

A structured case record proforma was used to collect demographic information, medical history, and duration of diabetes, anthropometric measurements, and laboratory investigation results. Anthropometric assessment included measurement of height and weight, and Body Mass Index (BMI) was calculated using the formula: BMI = Weight (kg)/Height (m^2).

All participants underwent biochemical evaluation after an overnight fast. Glycemic assessment included fasting blood sugar (FBS), postprandial blood sugar (PPBS), and glycated hemoglobin (HbA1c). Renal function was assessed using blood urea, serum creatinine, and urinary microalbumin levels. Lipid profile analysis included total cholesterol, triglycerides, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, and very low-density lipoprotein (VLDL) cholesterol. These parameters were analyzed to evaluate their association with circulating serum vaspin levels and diabetic complications.

Serum Vaspin Estimation: Venous blood samples were collected after overnight fasting. Serum was separated and stored under recommended laboratory conditions. Serum vaspin concentrations were measured using enzyme-linked immunosorbent assay (ELISA) kits according to manufacturer instructions.

Statistical Analysis: The collected data were entered into Microsoft Excel and subsequently analyzed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were used to summarize the study variables and were expressed as mean, standard deviation, frequency, and percentage, as appropriate. Comparisons between the study groups were performed using the Independent Student's t-test for continuous variables and the Chi-square test for

categorical variables. Pearson's correlation analysis was employed to determine the relationship between serum vaspin levels and various metabolic, glycemic, lipid, and renal parameters.

A p-value of less than 0.05 was considered statistically significant for all statistical analyses.

Results

A total of 50 patients with Type 2 Diabetes Mellitus were included in the study. Among them, 25 patients had established diabetic complications (Group I) and 25 patients had no documented complications (Group II). The demographic characteristics of the study participants were comparable between the groups. However, significant differences were observed in metabolic, renal, and adipokine profiles.

Table 1. Comparison of Anthropometric and Glycemic Parameters between Study Groups

Parameter	T2DM without Complications (n=25) Mean ± SD	T2DM with Complications (n=25) Mean ± SD	t-value	p-value
Age (years)	53.2 ± 7.1	54.8 ± 6.9	0.81	0.421
BMI (kg/m²)	25.6 ± 2.8	29.1 ± 3.5	3.92	<0.001*
FBS (mg/dL)	132.4 ± 24.5	186.7 ± 35.2	6.24	<0.001*
PPBS (mg/dL)	198.6 ± 41.8	284.5 ± 52.7	6.41	<0.001*
HbA1c (%)	7.4 ± 0.9	9.8 ± 1.3	7.56	<0.001*

***Significant at p<0.05**

Patients with diabetic complications exhibited significantly higher BMI, fasting blood glucose, postprandial blood glucose, and HbA1c levels compared to those without complications. No significant difference was observed with respect to age. These findings indicate poorer glycemic control and greater insulin resistance among patients with complications.

Table 2. Comparison of Lipid Profile and Renal Function Parameters

Parameter	T2DM without Complications (n=25) Mean ± SD	T2DM with Complications (n=25) Mean ± SD	t-value	p-value
Total Cholesterol (mg/dL)	184.2 ± 26.5	191.6 ± 31.4	1.02	0.311
Triglycerides (mg/dL)	151.8 ± 38.4	218.3 ± 45.2	5.61	<0.001*
HDL (mg/dL)	43.5 ± 6.4	38.7 ± 5.2	2.89	0.006*
LDL (mg/dL)	104.8 ± 21.5	138.9 ± 26.7	4.98	<0.001*
Urea (mg/dL)	28.4 ± 6.3	47.2 ± 12.5	6.84	<0.001*
Creatinine (mg/dL)	0.94 ± 0.18	1.63 ± 0.52	6.22	<0.001*
Microalbuminuria (mg/L)	24.3 ± 8.6	76.4 ± 22.8	10.12	<0.001*

***Significant at p<0.05**

Triglycerides, LDL cholesterol, urea, creatinine, and microalbuminuria were significantly elevated among diabetic patients with complications. HDL cholesterol was significantly lower in the complication group. Total cholesterol did not differ significantly between the groups.

Table 3. Correlation of Serum Vaspin Levels with Metabolic Parameters

Variable	Correlation Coefficient (r)	p-value
BMI	-0.58	<0.001*
FBS	-0.63	<0.001*
PPBS	-0.60	<0.001*
HbA1c	-0.67	<0.001*
Triglycerides	-0.52	0.002*
LDL Cholesterol	-0.48	0.004*
Microalbuminuria	-0.71	<0.001*
Creatinine	-0.56	<0.001*

***Significant at p<0.05**

Serum vaspin levels demonstrated significant negative correlations with BMI, glycemic indices, lipid abnormalities, renal dysfunction, and microalbuminuria. The strongest correlation was observed with microalbuminuria (r = -0.71), suggesting a close association between declining vaspin levels and diabetic end-organ damage.

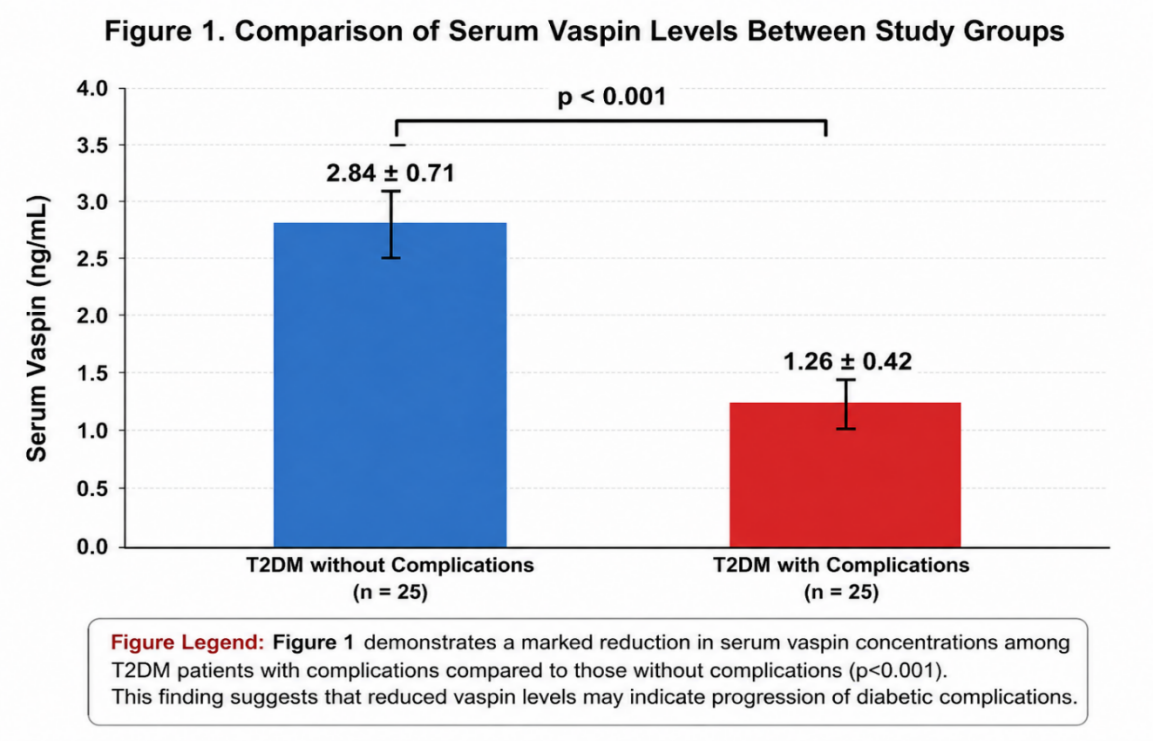

Figure 1:

Figure 1 demonstrates a marked reduction in serum vaspin concentrations among T2DM patients with complications compared to those without complications (p<0.001). This finding suggests that reduced vaspin levels may indicate progression of diabetic complications.

As shown in **Figure 1**, serum vaspin concentrations were significantly lower in patients with diabetic complications, indicating a potential protective role of vaspin against metabolic and vascular injury.

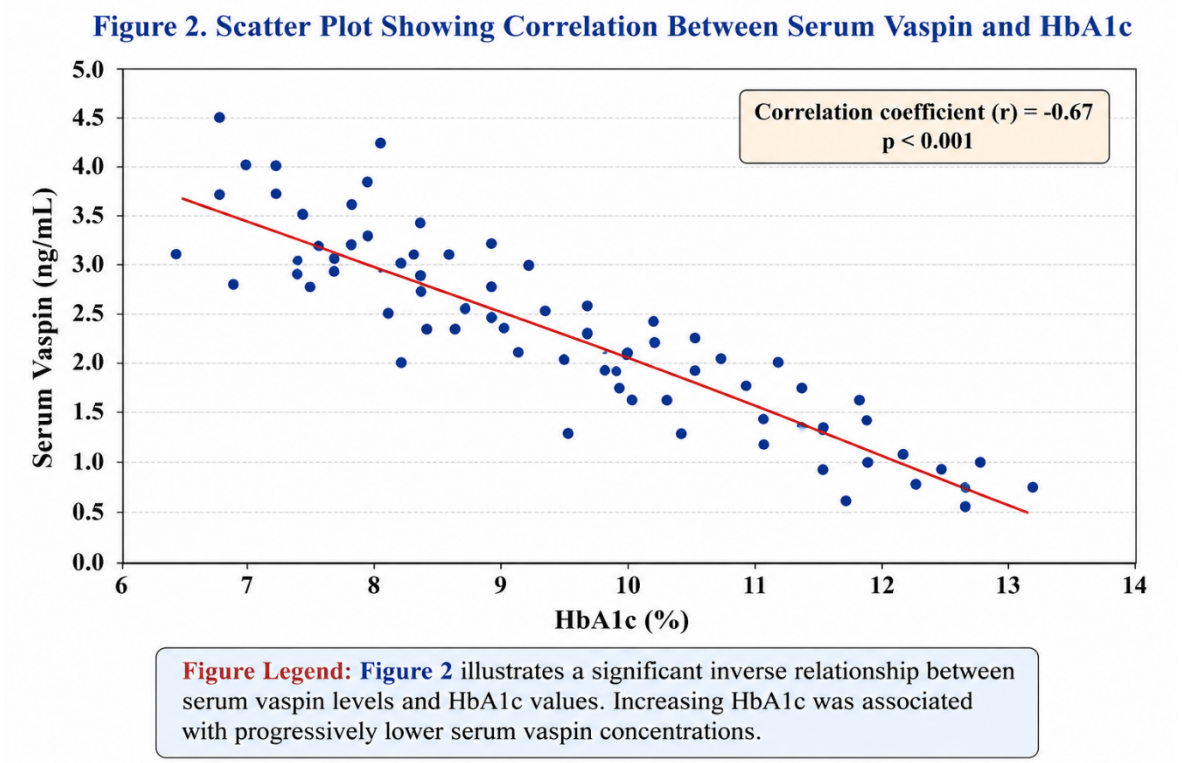

Figure 2. Scatter Plot Showing Correlation between Serum Vaspin and HbA1c (Correlation coefficient (r) = -0.67, p <0.001)

Figure 2 illustrates a significant inverse relationship between serum vaspin levels and HbA1c values. Increasing HbA1c was associated with progressively lower serum vaspin concentrations.

The scatter plot presented in Figure 2 reveals a significant negative correlation between serum vaspin and HbA1c levels, supporting the role of vaspin as a marker of worsening glycemic control.

Figure 3. Scatter Plot Showing Correlation Between Serum Vaspin and Microalbuminuria

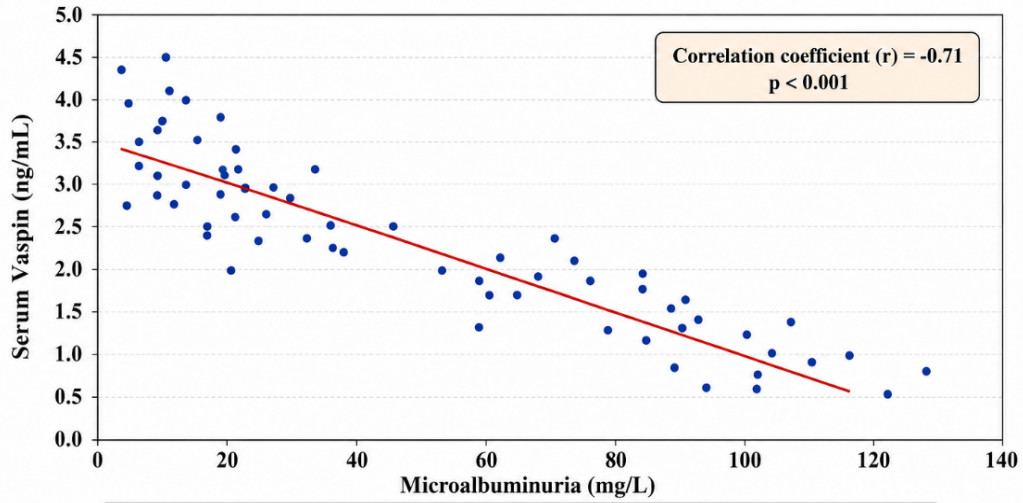

Figure Legend: Figure 3 demonstrates a strong inverse association between serum vaspin levels and microalbuminuria. Patients with greater renal involvement exhibited substantially lower circulating vaspin concentrations.

Figure Citation in Text: As depicted in Figure 3, serum vaspin levels declined significantly with increasing microalbuminuria, suggesting that vaspin may serve as an early biomarker of diabetic nephropathy and end-organ damage.

Figure 3. Scatter Plot Showing Correlation between Serum Vaspin and Microalbuminuria (Correlation coefficient (r) = -0.71, p <0.001)

Figure 3 demonstrates a strong inverse association between serum vaspin levels and microalbuminuria. Patients with greater renal involvement exhibited substantially lower circulating vaspin concentrations.

As depicted in Figure 3, serum vaspin levels declined significantly with increasing microalbuminuria, suggesting that vaspin may serve as an early biomarker of diabetic nephropathy and end-organ damage. The present study demonstrated that patients with Type 2 Diabetes Mellitus and complications had significantly lower serum vaspin levels along with higher BMI, poorer glycemic control, dyslipidemia, renal dysfunction, and microalbuminuria. Serum vaspin showed significant inverse correlations with markers of insulin resistance and diabetic complications, supporting its potential utility as a biomarker for early detection of diabetic end-organ damage.

Discussion

The present study investigated the relationship between serum vaspin levels and diabetic complications among patients with Type 2 Diabetes Mellitus. The principal finding was a significant reduction in serum vaspin levels among patients with diabetic complications compared with those without complications. This finding supports the hypothesis that vaspin may function as a compensatory adipokine involved in maintaining glucose homeostasis and insulin sensitivity.

The observed negative correlation between vaspin and BMI indicates that increasing adiposity and worsening metabolic dysfunction are associated with declining vaspin concentrations. Similar findings have been reported by Youn et al. and Esaki et al., who demonstrated significant associations between obesity and circulating vaspin levels [11-14]. The negative correlations between serum vaspin and glycemic parameters including FBS, PPBS, and HbA1c suggest that vaspin may reflect the degree of insulin resistance and glycemic deterioration. Previous studies have shown that vaspin influences insulin signaling pathways and may enhance glucose utilization in peripheral tissues [15-16].

The significant elevations of triglycerides and LDL cholesterol in patients with complications further emphasize the role of dyslipidemia in diabetic progression. As an adipokine secreted from visceral adipose tissue, vaspin may be involved in lipid metabolism and inflammatory regulation [17-19].

Renal dysfunction, reflected by elevated urea, creatinine, and microalbuminuria, was also associated with reduced vaspin levels. These

findings indicate a possible relationship between declining vaspin concentrations and diabetic nephropathy [20-22].

The anti-inflammatory and anti-atherogenic properties of vaspin may explain its protective role against vascular injury. Reduced serum vaspin concentrations may therefore contribute to endothelial dysfunction, accelerated atherosclerosis, and progression of diabetic complications [23-25].

Overall, the findings suggest that serum vaspin may serve as a useful biomarker for identifying T2DM patients at increased risk of complications and for monitoring disease progression.

Strengths of the Study: The present study possesses several notable strengths. It evaluated serum vaspin, a relatively novel adipokine biomarker, thereby contributing to the growing body of evidence regarding its role in Type 2 Diabetes Mellitus and its complications. The study design enabled a direct comparison between T2DM patients with complications and those without complications, facilitating a better understanding of the association between serum vaspin levels and disease progression. A comprehensive metabolic assessment was performed, including anthropometric measurements, glycemic parameters, lipid profile, renal function tests, and microalbuminuria, allowing a holistic evaluation of the metabolic alterations associated with diabetic complications. Furthermore, the findings have potential clinical relevance, as serum vaspin may serve as a useful biomarker for risk stratification, early detection, and monitoring of diabetic complications in routine clinical practice.

Limitations: The present study has certain limitations that should be considered while interpreting the findings. The sample size was relatively small, which may limit the statistical power and generalizability of the results.

An unequal gender distribution was observed among the study participants, which may have influenced the assessment of gender-specific associations with serum vaspin levels.

Furthermore, this was a single-center study, and therefore the findings may not be representative of the broader diabetic population. Several potential confounding factors, including dietary habits, physical activity levels, medication use, and genetic polymorphisms, were not evaluated and could have influenced serum vaspin concentrations. In addition, the cross-sectional design and lack of longitudinal follow-up precluded the assessment of temporal changes in vaspin levels and their predictive value for the development and progression of diabetic complications.

Future Recommendations: Future research should focus on conducting large multicenter studies with a larger and more diverse study population to validate the findings and improve their generalizability. Prospective cohort studies are warranted to determine the predictive value of serum vaspin levels for the development and progression of diabetic complications. Further investigation into the genetic, molecular, and pathophysiological mechanisms underlying the role of vaspin in insulin resistance and diabetes is essential. Additionally, the therapeutic potential of vaspin modulation should be explored as a possible strategy for preventing or delaying diabetic complications. Integrating serum vaspin measurements with existing diabetic risk prediction models may enhance prognostic accuracy and facilitate early identification of high-risk individuals, thereby improving clinical outcomes.

Conclusion

Serum vaspin levels are significantly decreased in Type 2 Diabetes Mellitus patients with complications compared to those without complications. Reduced vaspin concentrations correlate with obesity, poor glycemic control, dyslipidemia, and renal dysfunction. These findings support the potential utility of serum vaspin as a biomarker for insulin resistance and diabetic complications. Early identification of patients with declining vaspin levels may facilitate timely interventions aimed at preventing disease progression and improving clinical outcomes.

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