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Original Research Article

Serum Vaspin as a Potential Adipokine Marker in Type 2 Diabetes Mellitus: A Comparative Cross-Sectional Study with Normoglycemic Controls

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Abstract

Background: Vaspin is an adipokine that may be involved in insulin resistance and metabolic regulation. However, its relationship with glycaemic control and lipid abnormalities in type 2 diabetes mellitus (T2DM) remains uncertain.

Methods: This comparative cross-sectional study included 240 adults: 120 patients with T2DM and 120 age- and sex-matched healthy controls. Serum vaspin was measured using a sandwich enzyme-linked immunosorbent assay. Glycaemic and lipid parameters were estimated using standard laboratory methods. Between-group differences were assessed using the independent-samples t-test. Pearson's correlation was used to examine the relationship of vaspin with glycaemic and lipid parameters.

Results: Mean serum vaspin was significantly higher in patients with T2DM than in controls (1.49 ± 0.25 vs 0.59 ± 0.09 ng/mL; $p<0.001$). Patients with T2DM had significantly higher FBS, PPBS, HbA1c, total cholesterol, triglycerides, LDL and VLDL and lower HDL levels (all $p<0.001$). Serum vaspin showed a strong positive correlation with HbA1c ($r=0.740$, $p<0.001$), but not with FBS or PPBS. It correlated positively with total cholesterol, triglycerides, LDL and VLDL and negatively with HDL (all $p<0.001$).

Conclusion: Serum vaspin was elevated in patients with T2DM and was associated with poor long-term glycaemic control and an adverse lipid profile. Further longitudinal studies are needed to determine its clinical value as a metabolic biomarker.

Keywords: Adipokine; Dyslipidaemia; Glycaemic Control; HbA1c; Type 2 Diabetes Mellitus; Vaspin.

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Introduction

Diabetes mellitus is a chronic metabolic disorder marked by persistent hyperglycaemia due to impaired insulin secretion, reduced insulin action, or both. Type 2 diabetes mellitus (T2DM) accounts for approximately 90–95% of all diabetes cases, and its prevalence continues to increase worldwide [1]. India carries a substantial share of this burden. Lifestyle changes, physical inactivity, unhealthy dietary habits, obesity, and genetic susceptibility contribute to the development of T2DM and its complications [2]. Insulin resistance and progressive pancreatic β-cell dysfunction are central to the development of T2DM. Chronic inflammation, oxidative stress, and abnormal lipid metabolism also contribute to disease progression [3]. Adipose tissue is now recognised as an active endocrine organ that releases bioactive substances called adipokines. These molecules influence insulin sensitivity, glucose and lipid metabolism, appetite, and inflammation. Altered adipokine secretion may therefore play an important role in T2DM [4]. Vaspin, or visceral adipose tissue-derived serine protease inhibitor, is an adipokine belonging to the serpin family. It was initially

identified in obese, insulin-resistant rats and was later detected in human adipose tissue and other organs. Vaspin may improve insulin action and exert anti-inflammatory and anti-atherogenic effects [5]. However, its relationship with T2DM remains uncertain. Some studies have reported increased serum vaspin levels as a compensatory response to insulin resistance, whereas others have found reduced levels in long-standing or poorly controlled diabetes [6]. Differences in ethnicity, obesity, disease duration, treatment, and metabolic control may explain these inconsistent findings [7].

Evidence regarding serum vaspin in Indian populations remains limited. Therefore, the present study compared serum vaspin levels between patients with T2DM and age- and sex-matched healthy individuals and examined its relationship with glycaemic status and lipid profile parameters.

Materials and Methods

This comparative cross-sectional study was conducted jointly in the Departments of Biochemistry and Medicine at Mahatma Gandhi Memorial Medical College and M.Y. Hospital, Indore, Madhya Pradesh, India, over one year. The study protocol was approved by the Institutional Ethics Committee of MGM Medical College, Indore. Written informed consent was obtained from all participants before enrolment, and the confidentiality of their information was maintained throughout the study.

The sample size was calculated using the formula for comparing two independent means, with a 95% confidence level and 90% power. The minimum required sample was 80 participants in each group. To improve the precision of the study, 240 participants were enrolled, including 120 patients with type 2 diabetes mellitus (T2DM) and 120 healthy controls. Patients were recruited from the inpatient and outpatient services of the Department of Medicine. T2DM was diagnosed according to the American Diabetes Association criteria. Apparently healthy controls with no previous history of diabetes and fasting blood glucose below 100 mg/dL were recruited from hospital staff, patient attendants, and the community. Controls were frequency matched with patients for sex and age within three years. Adults aged 40 years or older who provided consent were included. Patients receiving insulin therapy or lipid-altering drugs, pregnant or lactating women, immunocompromised individuals, transplant recipients, long-term corticosteroid users, and participants with malignancy or acute or chronic inflammatory conditions were excluded.

Sociodemographic and clinical information was collected using a predesigned and pretested proforma. After an overnight fast of 8–10 hours, 5 mL of venous blood was collected between 8:00 AM and 10:00 AM under aseptic precautions. Blood collected in clot-activator tubes was allowed to clot for 30 minutes and centrifuged at 3,000 rpm for 10 minutes. The separated serum was transferred to labelled cryovials and stored at −20°C until analysis. Plasma samples were used for fasting and postprandial blood glucose estimation, while EDTA whole-blood samples were used to measure glycated haemoglobin.

Serum vaspin was measured in duplicate using a commercially available sandwich enzyme-linked immunosorbent assay kit according to the manufacturer's instructions. In this assay, vaspin in the sample bound to specific antibodies coated on the microplate. A biotin-labelled detection antibody and avidin–horseradish peroxidase conjugate were subsequently added. Following incubation and washing, a chromogenic substrate was added, and the resulting colour intensity was measured at 450 nm. Serum vaspin concentration was calculated from the standard calibration curve and expressed in ng/mL.

Fasting and postprandial blood glucose were measured using standard enzymatic methods, while HbA1c was estimated according to the institutional laboratory protocol. Total cholesterol and triglycerides were measured using the CHOD-POD and GPO-POD methods, respectively. HDL cholesterol was estimated after the precipitation of other lipoproteins. LDL cholesterol was calculated using the Friedewald formula, and VLDL cholesterol was calculated as triglycerides divided by five when triglyceride levels were below 400 mg/dL. Glucose and lipid values were expressed in mg/dL. Instruments were calibrated regularly, and internal quality-control procedures were followed.

Data were entered into Microsoft Excel and analysed using SPSS version 25.0. Continuous variables were reported as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Normality was assessed using the Shapiro–Wilk test. The independent-samples t-test was used to compare continuous variables, and the chi-square test was used for categorical variables. Pearson's correlation coefficient was applied to assess the relationships of serum vaspin with glycaemic and lipid parameters among patients with T2DM. A p-value <0.05 was considered statistically significant.

Results

A total of 240 participants were included, with 120 individuals each in the T2DM and control groups. In the T2DM group, 40.0% were aged 61–70 years, compared with 33.3% of controls. The mean age was 56.65 ± 8.95 years among patients with T2DM and 54.78 ± 9.13 years among controls. Males

constituted 51.7% and 52.5% of the respective groups. No significant differences were observed in age or sex distribution, indicating that the groups were demographically comparable (Table 1).

The mean serum vaspin level was significantly higher in the T2DM group than in the control group (1.49 ± 0.25 versus 0.59 ± 0.09 ng/mL; p<0.001). FBS, PPBS and HbA1c were also significantly higher among patients with T2DM. Compared with controls, patients with T2DM had significantly higher total cholesterol, triglycerides, LDL and VLDL levels, whereas their mean HDL level was significantly lower. All differences in glycaemic and lipid parameters were statistically significant (p<0.001) (Table 2). Among patients with T2DM, serum vaspin showed a strong positive correlation with HbA1c (r=0.740, p<0.001). However, no significant correlation was observed between serum vaspin and FBS (r=−0.031, p=0.740) or PPBS (r=0.120, p=0.194). Thus, serum vaspin was associated with long-term glycaemic status but not with the measured short-term glucose values (Table 3).

Serum vaspin showed significant positive correlations with total cholesterol (r=0.412), triglycerides (r=0.458), LDL (r=0.389) and VLDL (r=0.436). In contrast, it showed a significant negative correlation with HDL (r=−0.365). All correlations with lipid parameters were statistically significant at p<0.001 (Table 4).

Table 1: Demographic characteristics of the study participants

Demographic characteristics		T2DM group (n=120)	Control group (n=120)	p-value
Age group, n (%)	40–50 years	33 (27.5)	48 (40.0)	0.123
	51–60 years	39 (32.5)	32 (26.7)	
	61–70 years	48 (40.0)	40 (33.3)	
Age, years, mean ± SD		56.65 ± 8.95	54.78 ± 9.13	0.111
Sex, n (%)	Male	62 (51.7)	63 (52.5)	0.897
	Female	58 (48.3)	57 (47.5)	
Chi-square test and independent t-test. A p-value <0.05 was statistically significant				

Table 2: Comparison of serum vaspin, glycaemic parameters, and lipid profile between the groups

Parameter	T2DM group (n=120)	Control group (n=120)	p-value
Serum vaspin (ng/mL)	1.49 ± 0.25	0.59 ± 0.09	<0.001
FBS (mg/dL)	177.76 ± 24.19	89.86 ± 5.90	<0.001
PPBS (mg/dL)	238.06 ± 34.11	118.28 ± 11.84	<0.001
HbA1c (%)	8.53 ± 0.86	5.31 ± 0.18	<0.001
Total cholesterol (mg/dL)	205.91 ± 14.72	174.53 ± 14.50	<0.001
Triglycerides (mg/dL)	214.92 ± 35.53	114.08 ± 21.38	<0.001
HDL cholesterol (mg/dL)	42.92 ± 7.78	54.85 ± 8.85	<0.001
LDL cholesterol (mg/dL)	125.07 ± 13.83	105.42 ± 14.78	<0.001
VLDL cholesterol (mg/dL)	42.98 ± 7.14	22.82 ± 4.31	<0.001
Independent t-test. A p-value <0.05 was statistically significant.			

Table 3: Correlation of serum vaspin with glycaemic parameters among patients with T2DM

Glycaemic parameter	Pearson's r	p-value
FBS	−0.031	0.740
PPBS	0.120	0.194
HbA1c	0.740	<0.001
Pearson's correlation test. A p-value <0.05 was statistically significant.		

Table 4: Correlation of serum vaspin with lipid parameters among patients with T2DM

Lipid parameter	Pearson's r	p-value
Total cholesterol	0.412	<0.001
Triglycerides	0.458	<0.001
HDL cholesterol	−0.365	<0.001
LDL cholesterol	0.389	<0.001
VLDL cholesterol	**0.458**	<0.001
Pearson's correlation test. A p-value <0.05 was statistically significant		

Discussion

The present study compared serum vaspin levels in 120 patients with type 2 diabetes mellitus (T2DM) and 120 healthy individuals. The groups were comparable in age and sex, reducing the possible influence of these factors on the results. The main finding was that serum vaspin was significantly higher in patients with T2DM than in controls. Vaspin also showed a strong positive correlation

with HbA1c and significant correlations with several lipid parameters.

Mean serum vaspin was 1.49 ± 0.25 ng/mL in the T2DM group and 0.59 ± 0.09 ng/mL in the control group. Similar increases among patients with T2DM have been reported by Bharty et al. (2023), Abed and Hamid (2022) and Priya et al. (2020) [8-10] . Feng et al. (2014) also found higher circulating vaspin levels in people with T2DM and obesity [11]. Vaspin is thought to have insulin-sensitising and anti-inflammatory actions. Its increased concentration may therefore represent a compensatory response by adipose tissue to insulin resistance and metabolic stress.

Some studies, however, have reported lower vaspin levels in patients with diabetes. Baig et al. (2021), Komosinska-Vassev et al. (2020) and Jian et al. (2014) observed findings different from those of the present study [12-14]. These variations may be related to ethnicity, body composition, duration of diabetes, treatment, glycaemic control, and the presence of complications. Vaspin may behave differently at different stages of T2DM. It may rise during the compensatory phase of insulin resistance but decrease when diabetes becomes advanced or complications develop. The lower levels reported in diabetic nephropathy by Mousa et al. (2024) support this possible stage-dependent pattern [15].

FBS, PPBS, and HbA1c were significantly higher in patients with T2DM. Serum vaspin showed a strong positive correlation with HbA1c but was not significantly correlated with FBS or PPBS. Similar associations with HbA1c were reported by Bozkurt Doğan et al. (2016), and Wang et al. (2024) [16,17]. As HbA1c reflects glycaemic exposure over several months, this finding suggests that vaspin may be more closely related to sustained metabolic disturbance than to glucose values measured at a single time point.

Patients with T2DM also had higher total cholesterol, triglycerides, LDL, and VLDL, together with lower HDL. Serum vaspin correlated positively with total cholesterol, triglycerides, LDL, and VLDL and negatively with HDL. Priya et al. (2020), Abed and Hamid (2022) reported comparable relationships [9,10]. These findings indicate that vaspin is associated with both chronic hyperglycaemia and diabetic dyslipidaemia, although the cross-sectional design cannot establish whether it has a causal role.

The study included an adequate, age- and sex-matched control group and used uniform laboratory procedures. Nevertheless, it was conducted at a single centre, and insulin, HOMA-IR, obesity measures, disease duration, medication use, and diabetic complications were not assessed. Longitudinal multicentre studies are required to determine whether vaspin can predict metabolic control or future complications.

Conclusion

Serum vaspin levels were significantly higher in patients with T2DM than in healthy individuals. Vaspin showed a strong positive correlation with HbA1c, positive correlations with total cholesterol, triglycerides, LDL and VLDL, and a negative correlation with HDL.

These findings show that vaspin is associated with chronic glycaemic status and diabetic dyslipidaemia. However, its clinical usefulness as a biomarker cannot be confirmed from this cross-sectional study. Larger longitudinal studies should examine its relationship with insulin resistance, treatment response and diabetic complications.

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