e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2025; 17(9); 640-643

Original Research Article

A Study of Serum Ischaemia Modified Albumin and Glycated Hemoglobin Status in Type-2 Diabetes Mellitus Patients Attending a Tertiary Care Hospital in Kolkata

Animesh Sardar Singh[1], Amirullah Ali[2], Debasish Mandal[3]

[1]Department of Biochemistry, Institute of Post Graduate Medical Education & Research (IPGME&R) & SSKM Hospital, Kolkata, West Bengal, India

[2]Assistant Professor, Department of Biochemistry, Sarat Chandra Chattopadhyay Government Medical College & Hospital, West Bengal, India

[3]HOD, Department of Biochemistry, Jalpaiguri Government Medical College, West Bengal, India

Received: 17-07-2025 / Revised: 16-08-2025 / Accepted: 17-09-2025

Corresponding Author: Amirullah Ali

Conflict of interest: Nil

Abstract:

Background: Ischemia-modified albumin (IMA) is a marker of oxidative stress and ischemia and has been reported to be elevated in diabetes mellitus. This study evaluated serum IMA and its correlation with glycated hemoglobin (HbA1c) in patients with poorly controlled type-2 diabetes mellitus (T2DM).

Materials & Methods: An observational, non-interventional, hospital-based cross-sectional study conducted at IPGME&R & SSKM Hospital, Kolkata. A total of 100 subjects (50 T2DM cases and 50 age- and sex-matched controls) were enrolled. Serum IMA was estimated by the cobalt-albumin binding (ACB) assay; HbA1c by HPLC; glucose by GOD-POD method. Statistical analysis used SPSS; $p < 0.05$ was considered significant.

Results: Mean IMA was significantly higher in cases (0.7108 ± 0.1549 ABSU) compared to controls (0.1985 ± 0.0658 ABSU), $p < 0.0001$. Mean HbA1c was also higher in cases 8.5240 ± 0.8434% vs 5.2780 ± 0.6018% in controls ($p < 0.0001$). FBS and PPBS were also significantly higher in cases. A strong positive correlation between IMA and HbA1c was observed ($r = 0.824$, $p < 0.0001$).

Conclusion: Serum IMA is elevated in poorly controlled T2DM and correlates strongly with HbA1c. IMA may serve as an adjunct biomarker for oxidative stress in diabetes.

Keywords: Type-2 diabetes mellitus, Ischemia modified albumin (IMA), HbA1c, Oxidative stress, Glycemic control, ABSU – Absorbance Unit.

Introduction

Type-2 diabetes mellitus (T2DM) is associated with chronic hyperglycemia and oxidative stress leading to micro- and macrovascular complications. Oxidative modification of serum albumin produces ischemia-modified albumin (IMA), measurable by cobalt-albumin binding assays. Several studies suggest that IMA is elevated in T2DM and may reflect hyperglycemia-induced oxidative damage. This study aims to assess serum IMA levels in poorly controlled T2DM and examine its correlation with HbA1c and blood glucose parameters.

Materials and Methods

Study design: Observational, non-interventional, hospital-based cross-sectional study conducted at the Department of Biochemistry and Department of Medicine, IPGME&R & SSKM Hospital, Kolkata.

Subjects: 100 participants (50 clinically diagnosed T2DM cases with poor glycemic control and 50 age- and sex-matched healthy controls). Inclusion criteria for cases followed ADA diagnostic thresholds. Exclusion criteria included acute ischemic events, chronic inflammatory diseases, severe hepatic or renal dysfunction, and unwillingness to participate. Informed consent and institutional ethics approval were obtained.

Sample collection and assays: Venous blood (5 mL) was collected; serum separated and stored at -20°C. IMA was measured using the cobalt-albumin binding (ACB) spectrophotometric assay (200 µL serum + 50 µL $CoCl_2$, incubate 10 min; add 50 µL DTT, incubate 2 min; add 1 mL NaCl; read absorbance at 470 nm). HbA1c was measured by HPLC; glucose by GOD-POD method.

Statistical analysis: Data were analyzed using SPSS. Continuous variables are presented as mean ± SD. Between-group comparisons were made using unpaired t-tests. Pearson correlation assessed relationships between IMA and glycemic markers.

A p-value <0.05 was considered statistically significant.

Results

Table 1: Comparison of biochemical parameters between cases and controls

Parameter	Cases (n=50)	Controls (n=50)	p-value
FBS (mg/dL)	207.68 ± 24.12	87.48 ± 12.69	<0.0001
PPBS (mg/dL)	319.02 ± 50.37	145.86 ± 16.49	<0.0001
HbA1c (%)	8.524 ± 0.8434	5.278 ± 0.6018	<0.0001
IMA (ABSU)	0.7108 ± 0.1549	0.1985 ± 0.0658	<0.0001

Table 2: Correlation of IMA with glycemic parameters (Pearson)

Correlation	r-value	p-value
IMA vs HbA1c	0.824	<0.0001
IMA vs FBS	0.891	<0.0001
IMA vs PPBS	0.807	0.0001

Table 3: Distribution of mean IMA (ABSU): Group

		Number	Mean	SD	Minimum	Maximum	Median	p-value
IMA (Absorbance unit)	Case	50	0.7108	0.1549	0.4120	0.9990	0.7045	<0.0001
	Control	50	0.1985	0.0658	0.1230	0.3650	0.1775	

Student unpaired t test =21.5246

In Case, the mean IMA (ABSU) (mean± s.d.) of patients was .7108±.1549.

In Control, the mean IMA (ABSU) (mean± s.d.) of patients was .1985±.0658.

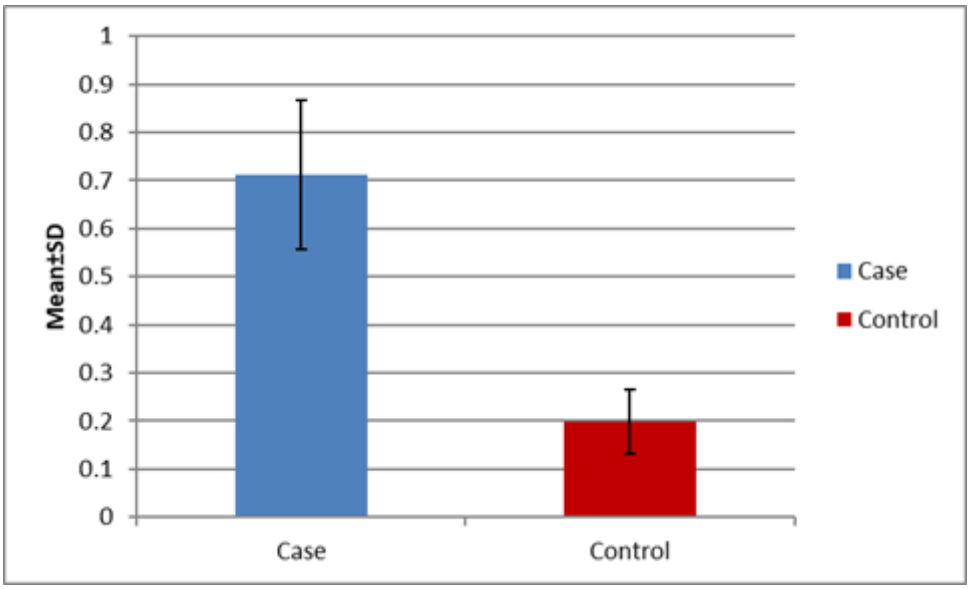

Chart 1: Distribution of mean IMA (ABSU) between case & control was statistically significant (p<0.0001)

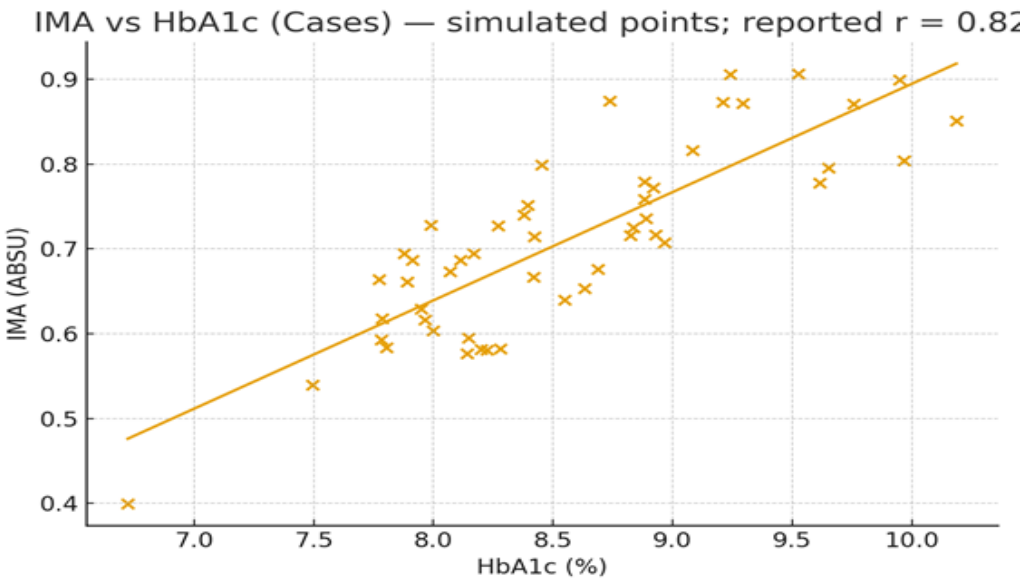

Chart 2: Scatter plot of simulated individual case data showing the relationship between IMA and HbA1c (reported Pearson r = 0.824)

Discussion

This study found significantly higher serum IMA levels in poorly controlled T2DM patients compared to controls, and a strong positive correlation between IMA and HbA1c (r = 0.824). These results align with prior reports suggesting that chronic hyperglycemia and associated oxidative stress induce structural modifications of albumin, increasing IMA concentration. IMA's elevation in diabetes likely reflects systemic oxidative damage and subclinical ischemia driven by persistent hyperglycemia, formation of advanced glycation end-products (AGEs), and mitochondrial ROS generation.

Human serum albumin is one of the circulating antioxidants in the plasma. It has an important role in the direct protective effect on oxidative stress [1]. Higher level of IMA was found in diabetic patients which confirms that it may be of non-cardiac origin [2]. IMA was also strongly correlated with risk factors for chronic complications such as inflammation and hyperglycemia [3]. Diabetic patients without an overt cardiovascular disease still may have a higher serum IMA level compared to healthy control and elevated IMA levels may indicate an underlying subclinical vascular disease in type 2 diabetes mellitus patients [4]. The observed strong correlation between IMA and HbA1c indicates that higher long-term glycemic burden is associated with greater albumin modification. IMA (Mean ± SEM) levels were found to be higher in the patients with poor glycaemic control compared to those with good glycaemic control and positively correlated with HbA1c levels [5]. It was also observed that ischemic modified albumin (IMA) has been shown to be a rapidly rising and sensitive biochemical marker especially for the diagnosis of myocardial ischemia. This supports the potential role of IMA as a complementary biomarker to HbA1c, providing insight into oxidative injury rather than glycemic exposure alone. Positive correlation between IMA and FBS and 2hr plasma glucose level was also found [7]. However, IMA is not disease-specific and can be elevated in multiple ischemic and non-ischemic conditions, so its use as a standalone diagnostic marker is limited. It was investigated that the role of protein oxidative damage and antioxidant defense in relationship to hyperglycemia measured as fasting plasma glucose (FPG), glycated hemoglobin (A1C), and duration of disease in type 2 diabetes mellitus (DM) and diabetic retinopathy (DR) [8]. It was found that exercise-induced calf muscle ischemia in healthy individuals is accompanied by an increase in IMA levels in serum, which return to baseline within 30 minutes. An investigation of myocardial markers under this condition did not show any significant association between changes of IMA and levels of lactate, cardiac troponin T (cTnT), and an N-terminal fragment of brain natriuretic peptide (NTproBNP) after ischemia [9]. In this context, the level of IMA in pregnant women is almost two times higher than in nonpreg in cases nant women and correlates with the level of thiobarbituric acid reactive substances (TBARS) [11]. Coronary artery disease (CAD) is a major vascular complication of diabetes mellitus and reveals high mortality. Up to 30 % of diabetic patients with myocardial ischemia remain asymptomatic and are associated with worse prognosis compared to non-diabetic counterparts, which warrants routine screening for CAD in diabetic population [10]. Monitoring IMA alongside established clinical and biochemical markers may

improve risk assessment for diabetic complications. Further longitudinal studies are needed to determine whether elevated IMA predicts future micro- or macrovascular complications. Studies also suggests that quantifying hs-CRP, IMA and Fibrinogen in cases levels can help diagnose the risk of developing complications during the early stages of metabolic and cardiovascular disease [12]. It was also found that ischemia-modified albumin (IMA) is reliable for early diagnosing symptomatic lacunar infarction (SLI) in type 2 diabetics [13].

Single-center cross-sectional design limits causal inference. Sample size (n=100) is modest; larger cohorts would improve statistical power. Raw subject-level data for all parameters were not available for external validation of plots (a simulated scatter was used for illustrative purposes). IMA measured by ACB assay may be influenced by albumin concentration and assay conditions; lack of a standardized IMA reference limits comparability.

Conclusion

Serum IMA is significantly elevated in poorly controlled T2DM and correlates strongly with HbA1c and blood glucose levels. IMA may serve as an inexpensive adjunctive biomarker reflecting hyperglycemia-induced oxidative stress and could aid in risk stratification for diabetic complications. Larger, multicentre prospective studies are warranted to clarify its prognostic value and specificity.

References

1. Bourdon E, Loreau N, Blanche D. Glucose and free radicals impair the antioxidant properties of serum albumin. FASEB J 1999; 12:233–244.
2. Afrah H, Sridhar R, Sushith S, Balakrishna P, Hanumanthappa M, Srinivasan M, Ramarajan M. Evaluation of Ischemia-Modified Albumin and Fibrinogen in Relation with High-Sensitive C-reactive Protein in Diabetic Foot Ulcers. Journal of Diabetes and Endocrine Practice. 2020 Sep;3(02):70-4.
3. Kaefer M, Piva SJ, De Carvalho JA, Da Silva DB, Becker AM, Coelho AC, Duarte MM, Moresco RN. Association between ischemia modified albumin, inflammation and hyperglycemia in type 2 diabetes mellitus. Clinical biochemistry. 2010 Mar 1;43(4-5):450-4.
4. Ukinc K, Eminagaoglu S, Onder Ersoz H, Erem C, Karahan C, Hacihasanoglu AB, Kocak M . A novel indicator of widespread endothelial damage and ischemia in diabetic patients: ischemia-modified albumin. 2009 Dec;36(3):425-32. doi: 10.1007/s12020-009-9236-5. Epub 2009 Sep 26
5. Chawla R, Loomba R, Guru D, Loomba V. Ischemia Modified Albumin (IMA) - A Marker of Glycaemic Control and Vascular Complications in Type 2 Diabetes Mellitus. 2016 Mar;10(3): BC13-6. doi: 10.7860/JCDR/2016/15282.7432. Epub 2016 Mar 1.
6. Patil P, Rao AV, Shetty S. Association of ischemia modified albumin with glycemic status in type II diabetes mellitus. Int J Recent Sci Res. 2017; 8:15374-8.
7. Thapa S, Rayamajhi RJ, Gautam S, Dahal S. Ischemia Modified Albumin Among Type 2 Diabetic Patients Visiting A Tertiary Care Center of Kathmandu. Journal of Chitwan Medical College 2020;10(33):74-78.
8. Reddy VS, Agrawal P, Sethi S, Gupta N, Garg R, Madaan H, Kumar V. Associations of FPG, A1C and disease duration with protein markers of oxidative damage and antioxidative defense in type 2 diabetes and diabetic retinopathy. Eye. 2015 Dec;29(12):1585-93
9. 9. 1. Falkensammer J., Stojakovic T., Huber K., et al. Serum levels of ischemia-modified albumin in healthy volunteers after exercise-induced calf-muscle ischemia. Clinical Chemistry and Laboratory Medicine. 2007;45(4):535–540. doi: 10.1515/CCLM.2007.087.
10. Irshad S, Riaz R, Ghafoor F. Value of serum glycated albumin in prediction of coronary artery disease in type 2 diabetes mellitus. Group. 2012;26(28.9):4.
11. 11. 1. Bahinipati J., Mohapatra P. C. Ischemia modified albumin as a marker of oxidative stress in normal pregnancy. Journal of Clinical and Diagnostic Research. 2016;10(9): BC15–BC17. doi: 10.7860/JCDR/2016/21609.8454.
12. Sushith S, Krishnamurthy HN, Reshma S, Madan G, Ashok KJ, Prathima MB, Kalal BS. Serum ischemia-modified albumin, fibrinogen, high sensitivity C-reactive proteins in type-2 diabetes mellitus without hypertension and diabetes mellitus with hypertension: a case-control study. Reports of biochemistry & molecular biology. 2020 Jul;9(2):241.
13. Ma SG, Xu W, Wei CL, Wu XJ, Hong B, Wang ZJ, Hao HR, Guo HQ. Role of ischemia-modified albumin and total homocysteine in estimating symptomatic lacunar infarction in type 2 diabetic patients. Clinical biochemistry. 2011 Nov 1;44(16):1299-303.