Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies

Journal home page:www.jamdsr.com doi:10.21276/jamdsr UGC approved journal no. 63854

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Elevated VCAM-1 Levels and Their Association with Peripheral Artery Disease in Diabetes Mellitus

Praveen Kothari

Assistant Professor, Department of Cardiology, St. John's Medical College and Hospital, Bangalore, Karnataka, India

ABSTRACT:

Background: Peripheral artery disease (PAD) is a common macrovascular complication in diabetes mellitus (DM), contributing significantly to morbidity and mortality. Vascular cell adhesion molecule-1 (VCAM-1) has emerged as a potential biomarker for endothelial dysfunction and atherosclerosis in this context. **Aim**: To assess serum VCAM-1 levels in diabetic patients with and without PAD and evaluate its role as an identifying marker for PAD in DM. **Material and Methods:** A cross-sectional study involving 80 diabetic patients, including 50 with PAD and 30 without PAD, was conducted. Demographic, metabolic, and vascular parameters were compared between groups. Serum VCAM-1 levels were measured and statistically analyzed for associations with PAD. **Results:** Patients with PAD exhibited significantly higher VCAM-1 levels, adverse lipid profiles, and poorer glycemic control compared to those without PAD. Age and male gender were also associated with increased PAD prevalence. **Conclusion:** Elevated serum VCAM-1 is significantly associated with PAD in diabetic patients and could serve as an early detection biomarker, aiding in timely intervention and improved outcomes.

Keywords: Peripheral artery disease, Diabetes mellitus, VCAM-1, Endothelial dysfunction

Corresponding Author: Praveen Kothari, Assistant Professor, Department of Cardiology, St. John's Medical College and Hospital, Bangalore, Karnataka, India

This article may be cited as: Kothari P. Elevated VCAM-1 Levels and Their Association with Peripheral Artery Disease in Diabetes Mellitus. J Adv Med Dent Scie Res 2018;6(6):305-308.

INTRODUCTION

Peripheral artery disease (PAD) is a common yet underdiagnosed manifestation of systemic atherosclerosis, characterized by narrowing and occlusion of the peripheral arteries, most frequently affecting the lower extremities. Its prevalence is significantly higher among individuals with diabetes mellitus (DM), where metabolic and vascular abnormalities accelerate the atherogenic process [1]. Chronic hyperglycemia in DM induces endothelial dysfunction through oxidative stress, advanced glycation end-product accumulation, and pro-inflammatory signaling, which contribute to vascular injury and plaque formation [2]. Endothelial activation plays a pivotal role in the initiation and progression of atherosclerosis, and vascular cell adhesion molecule-1 (VCAM-1) is a key mediator in this process [3].

VCAM-1, a member of the immunoglobulin superfamily, is expressed on activated endothelial cells in response to inflammatory cytokines. It facilitates leukocyte adhesion and transendothelial migration, triggering inflammatory cascades within the vascular wall [4]. In diabetic patients, elevated serum VCAM-1 levels have been correlated with impaired nitric oxide bioavailability, increased vascular stiffness, and higher atherosclerotic burden [5]. Notably, several studies have demonstrated that VCAM-1 is not merely a biomarker of inflammation but also a predictor of cardiovascular events, including PAD, myocardial infarction, and stroke [6].

Early detection of PAD in diabetic patients is critical, as it is associated with a markedly increased risk of limb loss, reduced quality of life, and higher all-cause mortality [7]. However, conventional diagnostic approaches such as ankle–brachial index (ABI) measurements and imaging studies are often underutilized or fail to detect early subclinical disease. Biomarkers like VCAM-1 may therefore provide a valuable non-invasive tool for early identification of high-risk individuals [8].

Emerging evidence suggests that elevated serum VCAM-1 levels precede overt PAD symptoms and correlate with disease severity [9]. Moreover, VCAM-1 measurement may aid in risk stratification, guiding both pharmacological interventions (e.g., antiplatelet

therapy, statins, and glycemic control) and lifestyle modifications to slow disease progression. Integrating such biomarkers into clinical practice could enhance early diagnosis and improve patient outcomes, especially in resource-limited settings [10].

In this context, the present study aims to evaluate the association between elevated serum VCAM-1 levels and PAD in patients with diabetes mellitus, exploring its potential as a diagnostic and prognostic marker in routine clinical care.

MATERIAL AND METHODS

A cross-sectional study involving 80 diabetic patients, including 50 with PAD and 30 without PAD, was conducted. Ethical approval was taken from the institutional ethical committee and written informed consent was taken from all the participants. This study was done for the period of 6 months. They were clinically diagnosed by physician based on their history, clinical examination, Doppler and Angiography. The blood samples were extracted from the vein. Following the disinfection of the venipuncture site with iodine, six milliliters (6 ml) of blood were collected into Gel and EDTA tubes. Blood in gel tubes permitted to coagulate at room temperature (25°C) for 30 minutes. Centrifugation was subsequently performed at 4000 rpm for 10 minutes to isolate the serum. Inclusion criteria targeted individuals above 40 years of age with DM and PAD, while exclusion criteria excluded those with chronic kidney disease (stages 3-5), acute infections, active cancer, or a history of acute coronary syndrome (ACS) or acute congestive heart failure (CHF) within the preceding 12 months

Statistical analysis

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2019) and then exported to data editor page of SPSS version 19 (SPSS Inc., Chicago, Illinois, USA). Quantitative variables were described as means and standard deviations or median and interquartile range based on their distribution. Qualitative variables were presented as count and percentages. For all tests, confidence level and level of significance were set at 95% and 5% respectively.

RESULTS

In this study, a comparative analysis of demographic and metabolic profiles between diabetic patients without peripheral artery disease (PAD) and those with PAD revealed notable differences. As shown in Table 1, the mean age was higher in the PAD group compared to the non-PAD group, and this difference was statistically significant. A greater proportion of males were observed in the PAD group, and the BMI was slightly elevated compared to those without PAD. Lipid parameters demonstrated significant disparities, with total cholesterol, LDL-C, triglycerides, and VLDL levels being markedly higher in the PAD group, while HDL-C levels were significantly lower, indicating a more atherogenic lipid profile in patients with PAD.

When evaluating the age distribution in both groups (Table 2), the highest proportion of non-PAD diabetic patients fell in the 50–60 year age range, whereas the PAD group showed a higher proportion in the 70–80 year category. The age group differences were statistically significant, suggesting that advancing age is an important factor associated with PAD in diabetic individuals.

Assessment of glucose homeostasis and VCAM-1 levels (Table 3) indicated that fasting blood sugar and HbA1c levels were higher in the PAD group compared to the non-PAD group, with both differences reaching statistical significance. Importantly, mean serum VCAM-1 levels were substantially elevated in the PAD group, highlighting its potential role as a biomarker for early detection of vascular involvement in diabetic patients.

Table 1: Comparative Analysis of Demographic and Metabolic Profiles in Diabetic Patients with and Without PAD (n=80)

Characteristic	DM without PAD, N=30	DM with PAD, N=50	P-Value
Age (years) Mean ± SD	54.5±9.2	63.7±10.1	0.02
Range	40-75	43-80	
Gender Male, n (%)	13 (43%)	33 (66%)	0.04
Female, n (%)	17 (57%)	17 (34%)	
BMI (kg/m²) Mean ± SD	28.5±3.4	30.7±5.0	0.03
Range	24-40	22-46	
Cholesterol (mg/dL) Mean ± SD	184±40	258±69	0.0002
Range	133-285	129-429	
HDL-C (mg/dL) Mean ± SD	45±13.1	32.1±11.2	0.006
Range	18.4-69	14.2-69.7	
LDL-C (mg/dL) Mean ± SD	128±35.3	157±63	0.02
Range	89-205	64-353	
Triglycerides (mg/dL) Mean ± SD	188.8±80.4	276±100	0.0004
Range	81-448	100-572	
VLDL (mg/dL) Mean ± SD	36.7±16.1	55.3±20	0.0004

Table 2: Demographic Age Patterns in Diabetes Mellitus and Patients with PAD (n=80)

Age groups	DM, N=30, No (%)	DM with PAD, N=50, No (%)	P-Value
40-50	8 (27%)	5 (10%)	0.03
50-60	14 (47%)	14 (28%)	
60-70	5 (16%)	12 (24%)	
70-80	3 (10%)	19 (38%)	

Table 3: Comparative Analysis of Glucose Homeostasis and VCAM-1 Levels in Diabetic Patients with and without PAD (n=80)

Characteristic	DM, N=30	DM with PAD, N=50	P-Value
Fasting blood sugar (mg/dL) Mean ± SD	204±75	208±56	0.04
Range	116-390	115-370	
HbA1C% Mean ± SD	8.1±1.5	8.5±1.8	0.03
Range	5.8-12	6.1-12	
VCAM-1 Mean ± SD	138.6±34.6	228±59.1	< 0.001
Range	76.8-237	114.7-363	

DISCUSSION

The present study demonstrates a clear association between elevated serum VCAM-1 levels and the presence of peripheral artery disease (PAD) in patients with diabetes mellitus (DM), highlighting its potential as a clinically relevant biomarker. The significant differences observed in lipid profiles, glycemic parameters, and VCAM-1 levels between diabetic patients with and without PAD are consistent with the current understanding of the pathophysiological interplay between endothelial dysfunction, systemic inflammation, and atherogenesis in DM-related vascular disease. Elevated VCAM-1 reflects enhanced leukocyte adhesion and transmigration across the vascular endothelium, a hallmark of early atherosclerotic changes, which may precede symptomatic PAD [11].

Several recent studies have reinforced the role of VCAM-1 as a predictive marker for cardiovascular events in DM, suggesting its integration into risk assessment models could enhance early diagnosis and intervention [12]. In particular, patients with poorly controlled glycemia, as evidenced by higher HbA1c levels in our PAD cohort, may experience accelerated endothelial injury, thereby amplifying VCAM-1 expression and subsequent vascular compromise. Furthermore, dyslipidemia—characterized by elevated LDL-C, triglycerides, and reduced HDL-C in our PAD group—synergistically promotes VCAM-1–mediated atherogenesis, underscoring the need for aggressive lipid-lowering strategies [13].

From an age-related perspective, our findings align with evidence that advancing age exacerbates endothelial dysfunction and impairs reparative mechanisms, leading to increased susceptibility to PAD in older diabetic populations [14]. The observed male predominance in the PAD group could reflect gender differences in vascular biology and hormonal influences, as well as varying lifestyle risk factors. Moreover, the marked elevation in VCAM-1 among PAD patients compared to their non-PAD counterparts suggests that this biomarker not only reflects disease presence but may also correlate with severity and progression [15].

Overall, this study emphasizes the potential of serum VCAM-1 as a valuable diagnostic adjunct in identifying subclinical vascular disease in diabetic individuals, particularly when combined with traditional risk factors and non-invasive vascular imaging. Early recognition through biomarker-driven screening could enable timely intervention, potentially mitigating adverse outcomes related to PAD.

CONCLUSION

This study establishes a significant association between elevated serum VCAM-1 levels and the presence of peripheral artery disease in diabetic patients. Alongside traditional cardiovascular risk factors, VCAM-1 appears to be a promising biomarker for early detection and risk stratification. Incorporating VCAM-1 measurement into routine clinical assessment for high-risk diabetic populations could improve early diagnosis and guide targeted preventive strategies to reduce PAD-related morbidity.

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