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ROLE OF INFLAMMATORY MARKERS IN CORONARY ARTERY DISEASE

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ABSTRACT

Aim

The aim of this article is to explore the role of inflammatory markers in the prediction and early detection of coronary artery disease (CAD), and to assess their potential use as predictive tools in clinical practice for improving early diagnosis and cardiovascular risk assessment.

Methods

A cross-sectional observational study was conducted on 50 participants, including 30 patients with angiographically confirmed coronary artery disease (CAD) and 20 age- and sex-matched controls without CAD. Blood samples were analyzed for inflammatory markers: high-sensitivity C-reactive protein (hs-CRP), interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and fibrinogen, using standard ELISA techniques. Statistical analysis was performed using SPSS version 25, with significance set at $p < 0.05$.

Results

Inflammatory marker levels were significantly higher in the CAD group compared to controls. The mean hs-CRP level in CAD patients was 4.8 ± 1.6 mg/L versus 2.1 ± 1.0 mg/L in controls ($p < 0.001$). IL-6, TNF-α, and fibrinogen were also elevated in CAD patients (all $p < 0.01$). A positive correlation was found between these markers and the severity of coronary artery disease.

Conclusion

The study confirms that inflammatory markers-particularly hs-CRP, IL-6, TNF-α, and fibrinogen-are significantly associated with the presence and severity of CAD. These findings suggest that inflammatory biomarkers may serve as valuable tools for risk assessment and early detection of coronary artery disease.

Keywords: Coronary artery disease (CAD), Inflammatory markers, High-sensitivity C-reactive protein (hs-CRP), Interleukin-6 (IL-6), Tumour necrosis factor-alpha (TNF-α), Fibrinogen, Cardiovascular risk prediction, Biomarkers.

INTRODUCTION

Coronary artery disease (CAD) remains a leading cause of morbidity and mortality worldwide, accounting for a significant proportion of cardiovascular-related deaths each year.[1] The pathogenesis of CAD is primarily driven by atherosclerosis, a chronic inflammatory process that leads to the formation of plaques within the arterial wall, compromising blood flow and increasing the risk of acute coronary events.[2] Traditionally, the assessment of CAD risk has relied on well-established clinical factors such as hypertension, dyslipidemia, diabetes mellitus, smoking, and family history. However, a substantial number of individuals experiencing cardiovascular events do not present with these conventional risk factors, highlighting the need for additional predictive tools.[3]

In recent years, increasing attention has been given to the role of inflammation in the initiation and progression of atherosclerosis. Inflammatory biomarkers, such as high-sensitivity C-reactive protein (hs-CRP), interleukin-6 (IL-6), tumour necrosis factor-alpha (TNF-α), and fibrinogen, have emerged as potential indicators of subclinical atherosclerotic activity.[4] These markers not only reflect underlying vascular inflammation but may also provide prognostic information independent of traditional risk factors.[5] Among these, hs-CRP has been the most extensively studied and has demonstrated a consistent association with future cardiovascular events in both healthy individuals and those with established CAD.[6] Other markers, such as IL-6 and myeloperoxidase (MPO), are gaining recognition for their potential roles in identifying vulnerable plaques and predicting adverse outcomes.[7]

Given the growing evidence supporting the link between systemic inflammation and atherosclerosis, the integration of inflammatory markers into cardiovascular risk assessment models may enhance the early identification of high-risk individuals and guide more personalized preventive strategies. This article aims to examine the predictive value of key inflammatory biomarkers in the context of CAD, discussing their clinical relevance, limitations, and future directions in cardiovascular risk stratification.

MATERIALS & METHODS

This study was designed as a **cross-sectional observational study** aimed at evaluating the association between inflammatory markers and the presence of coronary artery disease (CAD). A total of 50 participants were enrolled in the study. Subjects were selected from patients attending the cardiology outpatient department of BGS MCH Medical College, Nagarur, Bangalore, Karnataka. The size was determined based on feasibility, available resources, and similar previous studies examining inflammatory biomarkers in cardiovascular disease. After obtaining informed consent, detailed demographic and clinical data were collected from each participant using a structured questionnaire. Clinical history, risk factors (such as smoking, diabetes, hypertension), and medication use were documented. For static analysis we did Chi-square test (for categorical variables) and p-value < 0.05 was considered statistically significant.

Inclusion Criteria

- Patients aged 30–70 years
- Both males and females
- Clinically suspected or diagnosed with CAD based on symptoms, ECG changes, or previous imaging
- Consent to participate in the study

Exclusion Criteria

- Patients with acute infections, autoimmune diseases, or chronic inflammatory conditions
- Those on anti-inflammatory medications (e.g., corticosteroids or NSAIDs)
- Pregnant or lactating women

Laboratory Investigations

Venous blood samples were collected under aseptic conditions for measurement of the following inflammatory markers:

- High-sensitivity C-reactive protein (hs-CRP)
- Interleukin-6 (IL-6)
- Tumour necrosis factor-alpha (TNF-α)
- Fibrinogen

Standard laboratory protocols and commercially available ELISA kits were used for marker quantification.

Diagnostic Evaluation

Participants underwent one or more of the following based on clinical indications:

- Electrocardiography (ECG)
- Echocardiography
- Stress testing
- Coronary angiography (when clinically indicated)

Patients were classified as having CAD based on angiographic findings or a combination of clinical and non-invasive imaging evidence.

RESULTS

A total of 50 participants were included in the study, consisting of 30 patients with confirmed coronary artery disease (CAD group) and 20 without CAD (control group). The mean age of participants was 56.4 ± 8.2 years. Males comprised 60% of the total study population.

Variable	CAD Group (n=30)	Control Group (n=20)	p-value
Age (years)	58.1 ± 7.5	53.9 ± 8.3	0.045*
Male gender (%)	19 (63.3%)	11 (55%)	0.54
Hypertension (%)	21 (70%)	8 (40%)	0.03*
Diabetes Mellitus (%)	17 (56.7%)	5 (25%)	0.02*
Smoking history (%)	13 (43.3%)	4 (20%)	0.07
BMI (kg/m²)	27.4 ± 3.1	25.1 ± 2.7	0.01*
Table 1: Baseline Demographic and Clinical Characteristics			
*Statistically significant at **p < 0.05**			

Risk Factor	Present (n)	Absent (n)	% with CAD	% without CAD
Hypertension	29	21	70%	30%
Diabetes	22	28	56.7%	43.3%
Smoking	17	33	43.3%	56.7%
Obesity (BMI>30)	12	38	24%	76%
Table 2: Risk Factor Distribution in CAD vs. Non-CAD				

	hs-CRP	IL-6	TNF-α	Fibrinogen
hs-CRP	1	0.68**	0.60**	0.55**
IL-6	0.68**	1	0.66**	0.52**
TNF-α	0.60**	0.66**	1	0.47*
Fibrinogen	0.55**	0.52**	0.47*	1
Table 3: Correlation Matrix of Inflammatory Markers				
*Correlation is significant at **p < 0.05**; **p < 0.01				

CAD Severity	hs-CRP (mg/L)	IL-6 (pg/mL)	TNF-α (pg/mL)	Fibrinogen (mg/dL)
Mild (n=10)	3.5 ± 0.9	5.6 ± 1.2	4.3 ± 0.8	390 ± 65
Moderate (n=12)	4.9 ± 1.1	7.4 ± 1.4	5.9 ± 1.0	430 ± 60
Severe (n=8)	6.2 ± 1.4	9.1 ± 1.6	6.8 ± 1.1	460 ± 50
p-value	**<0.001**	**<0.001**	**0.003**	**0.02**

Table 4: Inflammatory Markers by CAD Severity (based on angiographic scoring)

Inflammatory Marker	CAD Group (n=30) Mean ± SD	Control Group (n=20) Mean ± SD	p-value
hs-CRP (mg/L)	4.8 ± 1.6	2.1 ± 1.0	**<0.001**
IL-6 (pg/mL)	7.2 ± 2.4	3.5 ± 1.1	**<0.001**
TNF-α (pg/mL)	5.6 ± 1.8	2.9 ± 1.0	**<0.001**
Fibrinogen (mg/dL)	420 ± 75	330 ± 60	**0.002**

Table 5: Comparison of Inflammatory Markers Between CAD and Control Groups

Correlation Analysis

A positive correlation was observed between hs-CRP and the severity of CAD as measured by angiographic scoring ($r = 0.62$, $\mathbf{p < 0.01}$). IL-6 and TNF-α also showed significant correlations with CAD severity ($r = 0.54$ and $r = 0.49$, respectively).

DISCUSSION

This study aimed to evaluate the association between inflammatory biomarkers and coronary artery disease (CAD) in a sample of 50 participants. The findings demonstrated that levels of high-sensitivity C-reactive protein (hs-CRP), interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and fibrinogen were significantly elevated in patients with confirmed CAD compared to controls. These results support the growing body of evidence that systemic inflammation plays a crucial role in the pathogenesis of atherosclerosis and its clinical manifestations.

Our findings are in agreement with those of Kaptoge et al., who conducted an individual participant meta-analysis and concluded that elevated hs-CRP levels are independently associated with increased risk of coronary heart disease, stroke, and vascular mortality.[8] Similarly, Pradhan et al. reported that both hs-CRP and IL-6 are predictive of not only cardiovascular events but also the development of type 2 diabetes, highlighting the role of low-grade inflammation in metabolic and vascular diseases.[9]

The elevated IL-6 levels observed in the CAD group are consistent with previous findings by Yudkin et al., who proposed IL-6 as a central mediator linking obesity, stress, and atherosclerosis.[10] IL-6 stimulates hepatic synthesis of acute-phase proteins like CRP and fibrinogen, further amplifying the inflammatory response within the vascular wall. In addition, Sesso et al. demonstrated that elevated baseline levels of IL-6 were associated with a significantly increased risk of myocardial infarction and stroke in apparently healthy men.[11]

The role of TNF-α in CAD has also been supported by previous research. Ridker et al. emphasized that TNF-α contributes to endothelial dysfunction and promotes plaque instability, which can precipitate acute coronary syndromes.[12] In our study, TNF-α levels were significantly higher in patients with severe angiographic CAD, suggesting its value as a marker of disease burden.

Fibrinogen, an acute-phase reactant, was also found to be significantly elevated in the CAD group. Luc et al. found a strong positive correlation between plasma fibrinogen levels and incident coronary events, independent of traditional risk factors.[13] Danesh et al. later corroborated these findings in a large-scale analysis, further validating fibrinogen's role in cardiovascular risk assessment.[14]

Finally, Kiechl et al. demonstrated through longitudinal data that elevated inflammatory marker levels, especially CRP and IL-6, predict future development of atherosclerotic lesions and cardiovascular events, even in asymptomatic individuals.[15]

These findings reinforce the clinical utility of inflammatory markers in identifying individuals at elevated cardiovascular risk. Our study, despite its limited sample size, provides additional evidence that hs-CRP, IL-6, TNF-α, and fibrinogen can serve as useful adjuncts in risk stratification for CAD.

CONCLUSION

This study demonstrates a significant association between elevated levels of inflammatory markers-namely hs-CRP, IL-6, TNF-α, and fibrinogen-and the presence and severity of coronary artery disease (CAD). Patients with angiographically confirmed CAD exhibited notably higher levels of these biomarkers compared to individuals without CAD.

Our findings are consistent with previously published data and support the hypothesis that chronic low-grade inflammation plays a central role in the pathogenesis and progression of atherosclerosis. The use of inflammatory markers, especially hs-CRP and IL-6, may offer a valuable addition to traditional risk assessment tools for early detection and management of CAD. Early identification of high-risk individuals using these markers could lead to timely preventive strategies and improved cardiovascular outcomes.

Further large-scale and longitudinal studies are recommended to validate these associations and to explore whether targeting inflammation could reduce the incidence or progression of CAD.

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