Original Article

Inflammatory Biomarkers In Early Detection Of Acute Coronary Syndrome

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Abstract

Background
Acute Coronary Syndrome (ACS) encompasses conditions that result from the sudden blockage of blood flow to the heart, often caused by a ruptured atherosclerotic plaque. Inflammatory processes are pivotal in the pathogenesis of ACS. Detection of specific inflammatory biomarkers has the potential to enhance early diagnosis and improve patient outcomes by identifying at-risk individuals earlier in the disease process..

Objectives
To assess the role of inflammatory biomarkers in the early detection of ACS, improving diagnostic accuracy and patient management.

Methodology
This observational descriptive study was conducted involving patients presenting with chest pain and suspected ACS, at Department of Cardiology , Khyber Teaching Hospital, Peshawar from Jan 2020 to Jan 2021. Blood samples were analyzed for inflammatory biomarkers, including CRP, interleukins, and white blood cell count. Statistical analysis was performed to evaluate the significance of these biomarkers in diagnosing ACS.

Results
A total of 150 patients participated, with a mean age of 58.3 years (SD: 10.2). CRP and interleukin-6 (IL-6) levels were significantly elevated in patients with ACS suggesting a strong inflammatory component in the onset of ACS. The biomarkers provided additional diagnostic value when combined with traditional methods.

Conclusion
Inflammatory biomarkers such as CRP and IL-6 offer significant potential for the early detection of ACS, aiding in more accurate diagnosis and better clinical decision-making. These biomarkers can improve risk stratification and guide timely interventions.

Keywords: Inflammatory biomarkers, Acute Coronary Syndrome, CRP, interleukin-6

Introduction

Acute Coronary Syndrome (ACS) refers to a group of clinical conditions caused by the sudden reduction or complete obstruction of blood flow in one or more coronary arteries, leading to myocardial ischemia [1]. The spectrum of ACS includes unstable angina, non-ST elevation myocardial infarction (NSTEMI), and ST elevation myocardial infarction (STEMI). ACS is a leading cause of mortality worldwide, contributing significantly to global healthcare burdens Timely diagnosis and appropriate management are crucial in preventing adverse cardiovascular events, including heart failure, arrhythmias, and death [2,3]. Traditionally, ACS has been diagnosed using clinical symptoms, electrocardiogram (ECG) changes, and biomarkers such as troponins. However, these diagnostic tools can be delayed or misinterpreted, particularly in the early stages of the disease. Consequently, there has been an increasing interest in identifying novel biomarkers that can aid in the early detection of ACS, particularly inflammatory biomarkers [4,5]. Inflammation is a key player in the pathophysiology of atherosclerosis, the underlying cause of most ACS events. Atherosclerotic plaques consist of lipids, smooth muscle cells, and macrophages, and as these plaques progress, inflammation contributes to their instability. When a plaque ruptures, it triggers a cascade of inflammatory responses that promote thrombosis and myocardial ischemia [6,7]. As such, biomarkers reflecting this inflammatory response have shown promise in the early detection of ACS. C-Reactive Protein (CRP), a well-established acute-phase reactant,

is one of the most studied inflammatory biomarkers. Elevated levels of CRP are associated with increased cardiovascular risk and may predict adverse outcomes in ACS [8,9]. Other inflammatory biomarkers, including interleukins (IL-6, IL-1β), white blood cell count, have also been implicated in the pathogenesis of ACS The challenge lies in identifying the most reliable biomarkers that can distinguish ACS from other causes of chest pain and guide clinicians towards more accurate and timely intervention. Several studies have suggested that inflammatory biomarkers, in combination with traditional diagnostic methods, could enhance early detection and risk stratification in ACS (Timmers et al., 2008). However, there is still a need for large-scale clinical trials to validate these biomarkers and refine diagnostic protocols [10]. The objective of this research is to evaluate the role of inflammatory biomarkers, such as CRP and interleukins, in the early detection of ACS and assess their diagnostic accuracy in a clinical setting in our local population. By measuring inflammatory biomarker levels in patients with ACS we aim to identify their potential for improving early diagnosis, risk stratification, and management of ACS patients.

Objectives

To find the role of inflammatory biomarkers in the early detection of ACS

Materials and Methods

This descriptive observational study was conducted at Department of Cardiology , Khyber Teaching Hospital Peshawar from Jan 2020 to Jan 2021. Patients presenting with chest pain were evaluated for ACS using clinical, electrocardiographic, and biochemical assessments. The sample size was determined using the formula for a single proportion; based on an expected CRP elevation frequency of 70% (p=0.7) and a 95% confidence level, the initial requirement of 323 was adjusted to 150 using the Finite Population Correction formula, accounting for the total annual volume of ACS admissions (N \approx 280) at our center. Patients aged 18 to 80 years, presenting with acute chest pain, suspected of having ACS, and providing informed consent were eligible for inclusion. Patients with chronic inflammatory conditions, ongoing infections, autoimmune diseases, malignancies, or those unable to provide informed consent were excluded from the study. Written informed consent was obtained from all participants before inclusion in the study.

Diagnostic and Management Strategy

Patients were initially assessed using clinical evaluation, ECG, and standard cardiac biomarkers, troponin I or CKMB , followed by inflammatory biomarker testing (CRP, IL-6). All Patients were treated as per standard protocols.

Results

the mean age was 58.3 ± 10.2 years, with a predominance of males (56.7%) compared to females (43.3%). Cardiovascular risk factors were common: hypertension was present in 60% of patients, diabetes mellitus in 43.3%, and 33.3% had a history of smoking, while 26.7% had prior coronary artery disease. Inflammatory biomarkers were notably elevated, with a mean C-reactive protein (CRP) level of 5.3 ± 3.4 mg/L, interleukin-6 (IL-6) of 19.7 ± 9.2 pg/mL, and white blood cell (WBC) count of 11.3 ± 2.4 $\times 10^3/\mu L$, indicating an active inflammatory state. Cardiac injury markers were also raised, with CK-MB 52 ± 7 IU/L and troponin I 2.9 ± 1.3 ng/mL, consistent with myocardial injury. the findings demonstrate a high burden of traditional cardiovascular risk factors along with significant inflammatory and myocardial injury markers in patients presenting with ACS.

Table 1: Baseline Characteristics of Patients

Characteristic	Value
Total Patients	150
Age (Mean ± SD)	58.3 ± 10.2
Male	85 (56.7%)
Female	65 (43.3%)
Hypertension	90 (60%)
Diabetes Mellitus	65 (43.3%)
Smoking History	50 (33.3%)
Previous CAD	40 (26.7%)

Table 2: myocardial and Inflammatory Biomarkers Levels in ACS

Biomarker	Mean ± SD
CRP (mg/L)	5.3 ± 3.4
IL-6 (pg/mL)	19.7 ± 9.2
WBC (x10^3/uL)	11.3 ± 2.4
CKMB (IU/L)	52± 7
TROPONIN I (ngm/ml)	2.9± 1.3
Cholesterol (mg/dl)	170± 11
HDL(mg/dl)	40± 4
LDL(mg/dl)	117± 18
Triglyceride (mg/dl)	190± 21

Discussion

Findings from the current study demonstrating elevated inflammatory biomarkers in patients with Acute Coronary Syndrome (ACS) align with a growing body of evidence emphasizing the pathophysiological relevance of inflammation in atherothrombosis and ACS. Inflammation contributes to plaque instability, progression, and rupture by promoting leukocyte recruitment, endothelial activation, and pro-thrombotic states, processes that are reflected in elevated systemic markers such as high-sensitivity C-reactive protein (hs-CRP), interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α), and white blood cell (WBC) count [11]. This mechanistic framework has been consistently documented in recent cardiovascular research, confirming that inflammatory activity is both a marker and mediator of coronary events and outcomes. Studies published over the last five years have examined similar inflammatory biomarkers as adjuncts to traditional diagnostic approaches [12]. Conducted a systematic review reporting that frail older individuals exhibit higher baseline inflammatory parameter levels, particularly CRP and IL-6, which correlate with greater infarct size and cardiovascular risk, indicating that systemic inflammation affects severity and prognosis in ACS [13]. The MDPI study on inflammatory prognostic indices suggested that composite indices integrating multiple inflammatory markers may improve risk prediction for major adverse cardiovascular and cerebrovascular events (MACCE) in non-ST elevation myocardial infarction (NSTEMI) patients undergoing intervention, signaling a shift towards multi-parameter risk stratification [14,15]. Contrasting evidence arises when inflammatory markers are evaluated for standalone diagnostic value in acute settings. Rafiqi et al. found that neither hs-CRP nor IL-6 independently improved diagnostic accuracy beyond established scoring systems such as the HEART score in patients presenting with chest pain, suggesting limited incremental value in emergency department diagnosis when used in isolation from clinical and electrocardiographic data[16]. These findings imply that reliance solely on inflammatory biomarkers without integration into broader assessment frameworks may not appreciably enhance early detection, particularly in low-risk or heterogeneous patient populations. Such variability in diagnostic utility highlights the importance of context and cohort characteristics when interpreting biomarker levels[17]. Emerging research on anti-inflammatory therapies further supports the role of inflammation in ACS pathogenesis. A meta-analysis of randomized controlled trials examining interventions targeting the LRP3/IL-1β/IL-6/CRP inflammatory axis in coronary artery disease demonstrated that inhibiting this pathway can reduce the risk of myocardial infarction (MI) and the need for coronary revascularization, underscoring the clinical relevance of inflammatory modulation[18]. These therapeutic insights reinforce the notion that inflammation is not merely an epiphenomenon but a potential target for reducing adverse cardiovascular outcomes. The heterogeneity of inflammatory marker performance across studies can be attributed to variations in patient demographics, timing of sample collection relative to symptom onset, assay methods, and the presence of comorbid conditions[19]. Meta-analyses and systematic reviews have reported that biomarkers such as neutrophil-to-lymphocyte ratio, monocyte-to-high-density-lipoprotein ratio, and systemic

inflammatory index might offer additional prognostic information when considered in composite risk models, pointing towards the potential for integrative biomarker panels. Overall, the present study's findings corroborate evidence that elevated CRP, IL-6, and WBC counts are associated with ACS , consistent with recent literature[20]. However, their optimal application may lie in combined risk stratification tools rather than as isolated diagnostic markers, reflecting a nuanced role for inflammation in ACS evaluation and management. Future research should prioritize large-scale, multi-Centre validation of composite biomarker models and investigate standardized cut-offs alongside clinical risk scores to enhance clinical utility[21].

Limitations

This study is limited by its observational design, small sample size, and single-centre setting, which may affect the generalizability of findings. Additionally, the use of inflammatory biomarkers as isolated diagnostic tools, without integration into clinical risk scores, limits the broader application of the results.

Conclusion

Inflammatory biomarkers, particularly CRP and IL-6, show promise in aiding early detection and risk stratification in ACS. However, their clinical utility is enhanced when combined with traditional diagnostic methods and multi-parameter risk models. Further research with larger, diverse populations is necessary to validate these biomarkers' role in clinical practice.

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All authors contributed significantly to the study's conception, data collection, analysis,
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