



## Comparative Analysis of Ischemia Modified Albumin and Coronary Artery Severity (Gensini Score) in Acute Coronary Syndrome

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### ABSTRACT

**Introduction:** Acute Coronary Syndrome (ACS) arises from impaired coronary blood flow due to atherosclerotic plaque and thrombosis. The Gensini score is used to assess the angiographic severity of coronary artery disease, while Ischemia Modified Albumin (IMA) serves as a biomarker for early myocardial ischemia. Comparing IMA with Gensini scores may help link biochemical changes to disease severity, aiding in timely diagnosis and risk stratification of ACS patients.

**Aim:** To compare the levels of serum Ischemia Modified Albumin (IMA) with coronary artery severity assessed by the Gensini score in patients with Acute Coronary Syndrome (ACS).

**Material and Method:** A total of 100 patients with Acute Coronary Syndrome (ACS) and 100 age and sex matched healthy controls were included in the study. All patients had coronary angiography done, and the severity of their coronary artery disease was calculated using the Gensini score. Blood samples were taken to measure the levels of Ischemia Modified Albumin (IMA). The IMA levels were then compared with the Gensini scores to see if there was a relationship between the blood test and the severity of blockage in the heart arteries. Statistical analysis was performed to determine the significance of the correlation.

**Results:** A total of 200 participants were studied, including 100 ACS patients (75 males, 25 females) and 100 controls (58 males, 42 females). The mean IMA level was significantly higher in ACS patients ( $13.31 \pm 6.41$  ng/mL) compared to controls ( $2.76 \pm 0.99$  ng/mL,  $P < 0.0001$ ). Based on Gensini scores, mean IMA levels increased with disease severity:  $7.26 \pm 2.37$  ng/mL (score 0–24),  $13.74 \pm 4.12$  ng/mL (score 25–53), and  $18.88 \pm 5.18$  ng/mL (score >53), showing a highly significant difference ( $P < 0.0001$ ).

**Conclusion:** The study findings suggest that serum Ischemia Modified Albumin (IMA) levels are significantly elevated in patients with Acute Coronary Syndrome (ACS) compared to controls. Moreover, IMA levels increase progressively with higher Gensini scores, indicating a strong association between this biomarker and the severity of coronary artery disease. Therefore, IMA can serve as a useful marker not only for early detection of ACS but also for assessing the severity of coronary artery involvement.

**Keywords:** Acute Coronary Syndrome (ACS), Ischemia Modified Albumin (IMA), Gensini Score, Coronary Artery Disease (CAD), Biomarker, Myocardial Ischemia, Risk Stratification.

## INTRODUCTION

Coronary artery disease, in which atherosclerotic plaque builds up inside the coronary arteries and restricts the flow of blood (and therefore the delivery of oxygen) to the heart, continues to be the number-one killer of Americans. Coronary artery disease can cause acute coronary syndrome (ACS), a condition characterized by signs of rapid myocardial ischemia, or an abrupt reduction in the heart's blood flow. The acronym ACS was chosen because it was believed to better describe the progression of the condition associated with myocardial ischemia. Unstable angina and myocardial infarction (MI) both come under the ACS. The signs and symptoms of ACS can vary greatly, ranging from unstable angina to non-ST segment elevation MI (NSTEMI) to ST-segment elevation MI (STEMI). Unstable angina and NSTEMI are generally caused by a partly or intermittently obstructed coronary artery, whereas STEMI is caused by a totally occluded coronary artery <sup>(1)</sup>. According to the World Health Organisation (WHO), the leading cause of death worldwide is cardiovascular disease, specifically acute coronary syndrome (ACS). In 2022, CVDs were predicted to have killed 19.8 million people or nearly 32% of all deaths globally. 85% of these deaths were from heart attacks and strokes <sup>(2)</sup>.

The sensitivity of admission ECGs is typically around 50%. As a result, a way to identify ischemia before necrosis appears and perform prompt revascularization is needed. Utilizing additional quantitative risk categorization methods as possible ischemia biomarkers presents a difficulty. To date, three markers have been proposed: ischemia modified albumin (IMA), free fatty acids, and choline <sup>(3)</sup>.

Ischemia episodes are preceded by IMA, a modified version of HAS (human serum albumin). IMA's sensitivity to ischemia conditions justifies its use. Albumin's structure changes as a result of ischemia's impact on the metabolic environment. The N-terminal portion of human serum albumin has the amino acid sequence N-(Aspartate) Asp-(Alanine) Ala-(Histidine) His-(Lysin) Lys. Transition metals such as cobalt (Co+2), copper (Cu+2), and nickel (Ni+2) bond to this area. When reactive oxygen species (ROS) are produced during ischemia, highly reactive hydroxyl free radicals are produced, which damage the N-terminal region of albumin.

This significantly alters albumin's ability to bind transition metals, particularly cobalt. This type of albumin was known as Ischemia Modified Albumin (IMA). IMA levels have been shown to increase within two minutes of the onset of ischemia, remain elevated for twelve hours, and then return to normal within twenty-four hours. Therefore, if IMA assessment is reliable and fast, it could be a potential marker for ACS patient identification. It might provide a more effective screening method for determining whether a person has acute myocardial ischemia when paired with standard practice.<sup>(4)</sup>

The Gensini score is an effective method for evaluating the extent and severity of atherosclerotic lesions in the coronary arteries. The Gensini score is an effective method for evaluating the extent and severity of atherosclerotic lesions in the coronary arteries. In this system, three main parameters need to be evaluated for each coronary lesion; severity score, segment multiplication factor and collateral correction factor. 2 Severity scores are as; 1 score for 1–25% stenosis, 2 score for 26–50% stenosis, 4 score for 51–75% stenosis, 8 score for 76–90% stenosis, 16 score for 91–99% stenosis, and 32 score for total (100%) occlusion <sup>(5)</sup>.

The relationship between the Gensini Score and acute coronary syndrome (ACS) has been extensively investigated, as the score provides a reliable estimate of coronary artery disease (CAD) burden and severity, which directly influences ACS presentation and prognosis.<sup>(6)</sup>

## MATERIAL AND METHODS

100 Patient's diagnosed with ACS, Visiting the in Patients Department (IPD) of Cardiology Fulfilling the inclusion and exclusion criteria were enrolled for the study. The control Group consisted of 100 age and sex matched healthy subjects. The study was conducted after taking approval from the Institutional Ethics Committee and obtaining consent from the willing participants. Inclusion criteria for the study was Patients with chest pain, Shortness of breath, Epigastric pain, Age above 18 year and who were interested in taking part in the study. Patients with hypoalbuminemia, Chronic inflammatory disorder, Liver disorder, Renal disorder, Brain ischemia, Pregnant & lactating females, Age below 18 year, Patient declined to participate were excluded from the study. Standard aseptic techniques were used to collect blood samples, and the Coronary angiography was used to calculate the Gensini score for assessing the severity of coronary artery disease, while serum Ischemia Modified Albumin (IMA) levels were measured using the ELISA method.

## RESULTS

A total of 200 participants were studied, including 100 ACS patients (75 males, 25 females) and 100 controls (58 males, 42 females). The mean IMA level was significantly higher in ACS patients ( $13.31 \pm 6.41$  ng/mL) compared to controls ( $2.76 \pm 0.99$  ng/mL,  $P < 0.0001$ ). Based on Gensini scores, mean IMA levels increased with disease severity:  $7.26 \pm 2.37$  ng/mL (score 0–24),  $13.74 \pm 4.12$  ng/mL (score 25–53), and  $18.88 \pm 5.18$  ng/mL (score >53), showing a highly significant difference ( $P < 0.0001$ ).

**Table no:1 Distribution of the subject on the basis of gender**

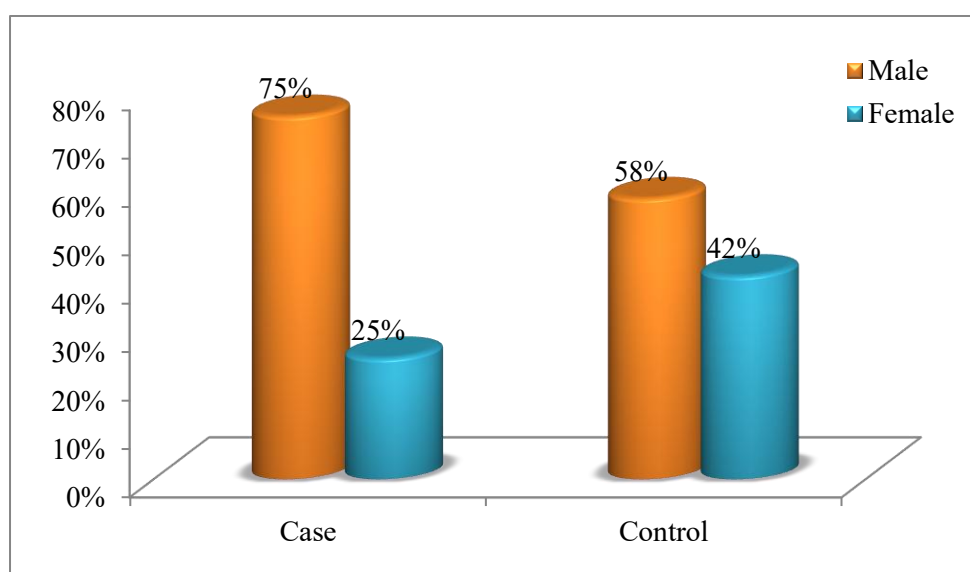
| <b>GENDER</b>          | <b>CASE (n=100)</b> | <b>CONTROL (n=100)</b> |
|------------------------|---------------------|------------------------|
| <b>MALE</b>            | 75                  | 58                     |
| <b>FEMALE</b>          | 25                  | 42                     |
| <b>NO. OF PATIENTS</b> | 100                 | 100                    |

**Table no:2 Comparison of mean IMA levels between Cases and Controls groups.**

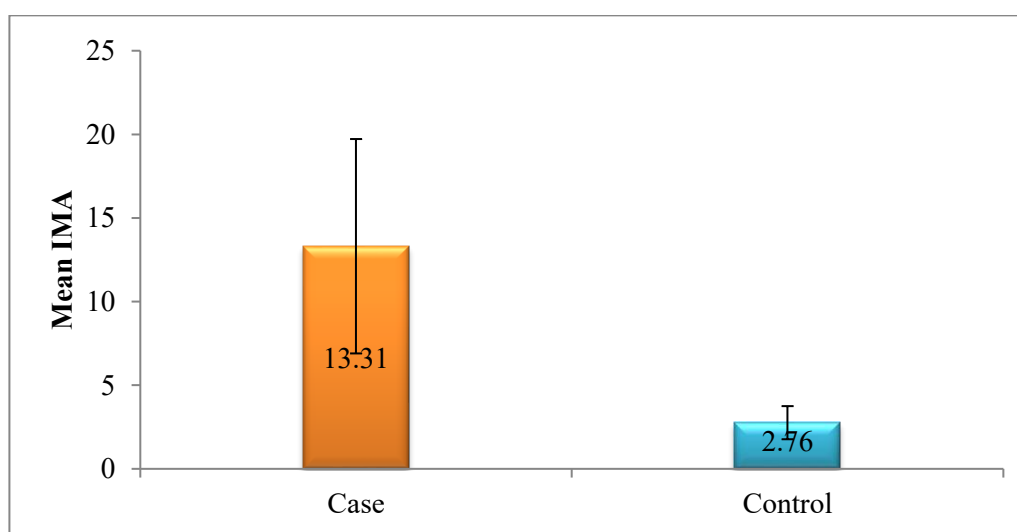
| <b>Variable</b>          | <b>Case</b> | <b>Control</b> | <b>t value</b> | <b>P-value</b> |
|--------------------------|-------------|----------------|----------------|----------------|
| <b>IMA level (ng/mL)</b> | 13.31±6.41  | 2.76±0.99      | 16.266         | <0.0001        |

**Table no: 3 Distribution of IMA on the basis of Gensini Score**

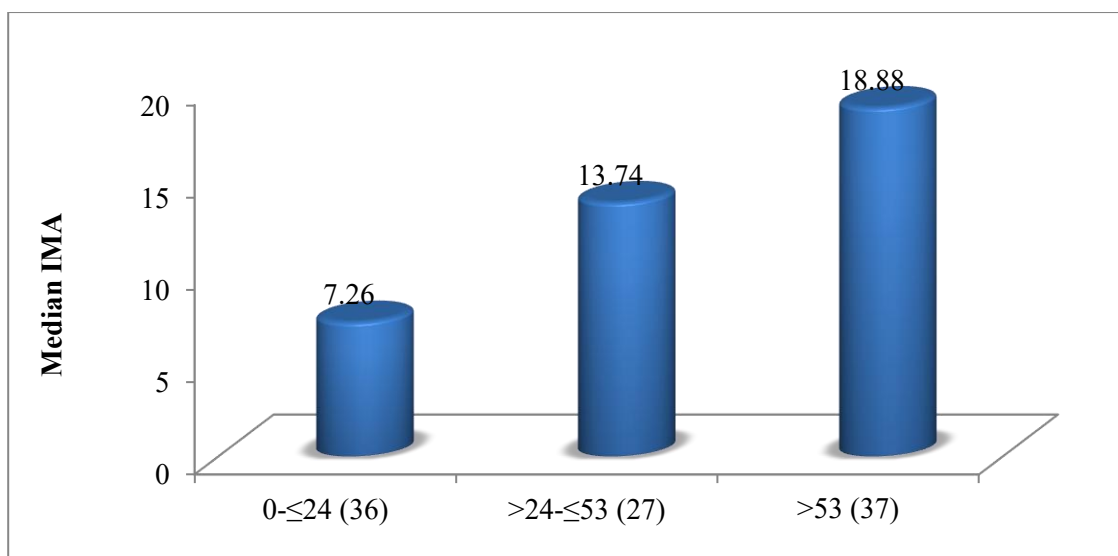
|                    | <b>0-≤24 (36)</b> | <b>&gt;24-≤53 (27)</b> | <b>&gt;53 (37)</b> | <b>F value</b> | <b>p-value</b> |
|--------------------|-------------------|------------------------|--------------------|----------------|----------------|
| <b>IMA (ng/mL)</b> | 7.26±2.37         | 13.74±4.12             | 18.88±5.18         | 74.71          | <0.0001        |



**Fig:1 Distribution of the subject on the basis of gender**



**Fig:2 Comparison of mean IMA levels between Cases and Controls groups.**



**Fig:3 Distribution of IMA on the basis of Gensini Score**

In the present study, the mean age was comparable between ACS patients and the control group. Serum IMA levels were significantly higher in ACS patients compared to controls. When analyzed according to Gensini score, IMA levels increased progressively with the severity of coronary artery disease, showing strong statistical significance. This suggests that higher IMA levels are associated with more severe coronary artery involvement, indicating that IMA can be a useful marker not only for early detection of ACS but also for assessing the extent of coronary artery disease.

According to the World Health Organization (WHO), cardiovascular disease, particularly ACS, is the leading cause of death globally. It was estimated that CVDs caused 19.8 million deaths in 2022, accounting for nearly 32% of all fatalities worldwide, with heart attacks and strokes responsible for 85% of these deaths (WHO, 2022) <sup>(7)</sup>.

In the present study, 75% of ACS cases were male and 25% were female. Across Unstable Angina, NSTEMI, and STEMI, the majority of patients were male, and the male-to-female ratio was similar to that of the control group. **Anthony N et al., 2024**<sup>(8)</sup> also reported that ACS was more prevalent in males (60%) compared to females (40%).

The study observed that IMA levels were significantly elevated in ACS patients compared to controls. Similar findings were reported by **Ralapanawa U et al., 2024**<sup>(9)</sup> supporting the potential of IMA as a diagnostic biomarker. **Aggarwal et al., 2011**<sup>(10)</sup> also found that IMA levels were significantly higher in patients with myocardial ischemia presenting with chest pain compared to controls.

When IMA levels were analyzed according to Gensini score, a statistically significant increase was observed with higher scores, indicating a correlation between IMA and the severity of coronary artery disease. **Toklu O et al., 2016**<sup>(11)</sup> demonstrated that IMA levels were a strong predictor of the extent and severity of coronary artery disease in patients with unstable angina, as determined by Gensini score. Similarly, **Demirtas A et al., 2013**<sup>(12)</sup> reported that IMA and BNP could predict the extent of coronary artery disease before performing coronary angiography, with Gensini score used to quantify severity and >50% stenosis considered severe.

Overall, these findings indicate that IMA is not only a sensitive marker for early detection of ACS but also correlates with angiographic severity, providing valuable information for risk stratification and management of patients with coronary artery disease.

## CONCLUSION

The study findings suggest that serum Ischemia Modified Albumin (IMA) levels are significantly elevated in patients with Acute Coronary Syndrome (ACS) compared to controls. Moreover, IMA levels increase progressively with higher Gensini scores, indicating a strong association between this biomarker and the severity of coronary artery disease. Therefore, IMA can serve as a useful marker not only for early detection of ACS but also for assessing the severity of coronary artery involvement.

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