

Review Article

Correlation of hs-troponin with Coronary Angiography Findings: Systematic Review

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ABSTRACT

Introduction: Coronary artery disease (CAD) remains a leading cause of global morbidity and mortality. Coronary angiography is considered the gold standard for evaluating coronary artery stenosis; however, its invasive nature limits widespread use. High-sensitivity cardiac troponin (hs-cTn) has emerged as a non-invasive biomarker capable of detecting minimal myocardial injury and may reflect the severity of coronary atherosclerosis. This systematic review aims to evaluate the relationship between hs-cTn levels and coronary angiography findings in patients with suspected or confirmed CAD. **Methods:** This systematic review was conducted in accordance with PRISMA 2020 guidelines. A comprehensive literature search was performed in PubMed, Scopus, Web of Science, and ScienceDirect databases for studies published between 2015 and 2025. Eligible studies included original research articles evaluating the association between hs-cTn levels (hs-cTnI or hs-cTnT) and coronary angiography findings, including stenosis severity, plaque burden, or angiographic scoring systems such as Gensini or SYNTAX scores. A total of 3,471 articles were identified, and 20 studies met the inclusion

criteria and were analyzed qualitatively. **Results and Conclusion:** The majority of included studies demonstrated a significant positive association between hs-cTn levels and the presence, severity, and complexity of coronary artery disease. Elevated hs-cTn levels were consistently associated with higher degrees of coronary stenosis, increased plaque burden, and more complex coronary lesions. Several studies indicated that hs-cTnI may provide higher predictive value than hs-cTnT, while low-level elevations of hs-cTn were shown to reflect subclinical atherosclerosis and improve risk stratification. Overall, hs-cTn shows strong potential as a non-invasive biomarker for assessing CAD severity; however, heterogeneity in study populations, assay types, diagnostic criteria, and confounding factors necessitates cautious interpretation. Further standardized prospective studies are required to strengthen the clinical applicability of hs-cTn in predicting coronary angiographic severity.

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1. INTRODUCTION

Coronary artery disease (CAD) is one of the major global health problems contributing significantly to cardiovascular morbidity and mortality. The World Health Organization (WHO) reports that CAD is the leading cause of death among non-communicable diseases, with a prevalence that continues to increase due to aging populations, lifestyle changes, and the rising incidence of risk factors such as hypertension, dyslipidemia, diabetes mellitus, and smoking habits. Early detection of atherosclerosis or coronary artery obstruction is essential to prevent myocardial infarction, heart failure, and other fatal cardiovascular complications.^{1,2}

Coronary angiography remains the gold standard for assessing coronary artery anatomy and the severity of vascular stenosis, as it provides accurate visualization of the location, length, and degree of arterial narrowing. However, this procedure is invasive, requires specialized expertise, and carries potential risks, including bleeding, arrhythmia, and adverse reactions to contrast agents. Additionally, coronary angiography is relatively expensive and not widely available in all healthcare facilities, particularly in resource-limited settings.³⁻⁵

Due to these limitations, recent research has focused on developing non-invasive biomarkers capable of detecting myocardial injury or atherosclerotic activity at an early stage. High-sensitivity troponin (hs-Troponin) is a next-generation cardiac biomarker that can detect minimal myocardial injury at very low concentrations with higher sensitivity than conventional troponin assays. The use of hs-Troponin has the potential to improve risk stratification in CAD patients and support early clinical decision-making without immediately requiring invasive procedures.¹⁻⁴

High-sensitivity troponin (hs-Tn) has been widely recognized for its ability to detect subtle myocardial damage with high analytical sensitivity. Several studies have

reported that hs-Troponin levels may reflect the burden of atherosclerosis and the complexity of coronary lesions. However, existing findings remain heterogeneous in terms of study design, population characteristics, troponin assay types, and angiographic assessment methods.

Several studies have demonstrated a correlation between hs-Troponin levels and angiographic findings related to coronary atherosclerosis severity. Nevertheless, the available evidence shows considerable variability, resulting in the absence of a consistent conclusion regarding the strength of this association.

Therefore, a comprehensive synthesis of scientific evidence is required to evaluate the relationship between hs-Troponin levels and coronary angiography findings. This systematic review aims to summarize and analyze existing studies to provide clearer evidence regarding the potential role of hs-Troponin as a non-invasive indicator for assessing the severity of coronary artery disease.

2. METHODS

This study is a systematic review conducted in accordance with the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. This review aims to comprehensively evaluate the relationship between high-sensitivity troponin (hs-Troponin) levels and coronary angiography findings in patients with suspected or confirmed coronary artery disease (CAD). The protocol for this systematic review was not registered in an international registry such as PROSPERO. However, all research procedures were conducted following PRISMA 2020 guidelines to ensure transparency, systematic methodology, and reproducibility.

The review methodology was conceptualized by Anni Fitria (AF), Sumarni (S), and Go Fillysia (GF). The literature search strategy was developed by AF and GFCG, with input from S, and searches were conducted in PubMed, Scopus, Web of Science, and ScienceDirect using the predefined search terms and Boolean operators described above. Following the literature search, titles and abstracts were screened independently by two reviewers (S and AF) against the predefined eligibility criteria. Full-text articles were subsequently assessed independently by the same reviewers to determine final eligibility. Disagreements regarding study selection were resolved through discussion, with S consulted when consensus could not be reached. Data extraction from eligible full-text articles was performed by AF and independently cross-checked by GF. Extracted information included authorship and publication year, study design, sample size, population characteristics, troponin assay type, coronary angiography assessment methods, measures of coronary artery disease severity, and reported associations between high-sensitivity troponin levels and angiographic findings. S contributed to the interpretation and synthesis of the extracted findings. The review findings were synthesized qualitatively, and the manuscript was drafted by AF with contributions from S and GF. All authors reviewed the manuscript, provided critical feedback, and approved the final version before submission.

The study selection process was documented using a PRISMA flow diagram. A systematic literature search was conducted using four international databases: PubMed, Scopus, Web of Science, and ScienceDirect. The search strategy employed combinations of Medical Subject Headings (MeSH) and free-text terms. The search queries used in each database were as follows:

1. PubMed:
("high-sensitivity troponin" OR "hs-troponin" OR "hs-cTnI" OR "hs-cTnT")
AND
("coronary angiography" OR "coronary artery disease" OR "coronary stenosis")
AND
("Gensini score" OR "SYNTAX score" OR "angiographic severity")
2. Scopus:
TITLE-ABS-KEY ("high-sensitivity troponin" OR "hs-troponin")
AND TITLE-ABS-KEY ("coronary angiography" OR "coronary artery disease")
AND TITLE-ABS-KEY ("Gensini" OR "SYNTAX" OR "coronary severity")
3. Web of Science:
TS=("high-sensitivity troponin" OR "hs-troponin")
AND TS=("coronary angiography" OR "coronary artery disease")
AND TS=("Gensini score" OR "SYNTAX score")
4. ScienceDirect:
("high-sensitivity troponin" OR "hs-troponin")
AND ("coronary angiography" OR "coronary artery disease")
AND ("Gensini score" OR "SYNTAX score")

Boolean operators AND and OR were used to improve the sensitivity and specificity of the search results.

The inclusion criteria for this review were:

1. Original research articles published within the last 10 years (2015–2025);
2. Articles written in English;
3. Full-text articles available;
4. Studies evaluating the relationship or correlation between hs-Troponin levels (hs-cTnI or hs-cTnT) and coronary angiography findings, including stenosis severity, number of lesions, or coronary anatomical scoring systems such as the Gensini score or SYNTAX score.

The exclusion criteria included:

1. Review articles, case reports, editorials, or letters to the editor;
2. Animal studies or in vitro experimental studies;
3. Studies that did not report quantitative relationships between hs-Troponin levels and coronary angiography findings;
4. Articles with incomplete data or duplicate publications.

The 10-year publication timeframe was selected to ensure that included studies utilized contemporary high-sensitivity troponin assays with improved analytical sensitivity and accuracy compared to earlier assays. Furthermore, this period reflects recent advancements in coronary angiography techniques and lesion complexity scoring systems, thereby enhancing the clinical relevance of the findings.

The study selection process was conducted in multiple stages. First, titles and abstracts were screened according to the inclusion and exclusion criteria. Eligible articles were then subjected to full-text review to determine final eligibility. The selection process was documented using a PRISMA flow diagram.

Data from eligible studies were extracted using a standardized extraction form that included the following information:

1. Author and year of publication

2. Study design
3. Sample size
4. Population characteristics
5. Type of troponin assay used
6. Coronary angiography assessment method
7. Parameters used to evaluate CAD severity
8. Correlation results between hs-Troponin levels and angiographic findings

The methodological quality and risk of bias of the included studies were assessed using the Newcastle–Ottawa Scale (NOS) for observational studies. The evaluation was based on three domains: selection of study participants, comparability of study groups, and outcome assessment. Studies were categorized as low, moderate, or high quality based on their NOS scores.

Data analysis was conducted descriptively and qualitatively by comparing the correlation results between hs-Troponin levels and coronary angiography findings across studies. If sufficient data homogeneity was identified, quantitative analysis (meta-analysis) was planned to pool study results using a random-effects model. However, if substantial heterogeneity was present, findings were presented through narrative synthesis.

3. RESULTS

The articles identified in the databases were filtered using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram, as shown in Figure 1. The search using Boolean phrases yielded 3,471 articles, which were then screened based on the inclusion criteria, resulting in 20 articles that met the eligibility requirements.

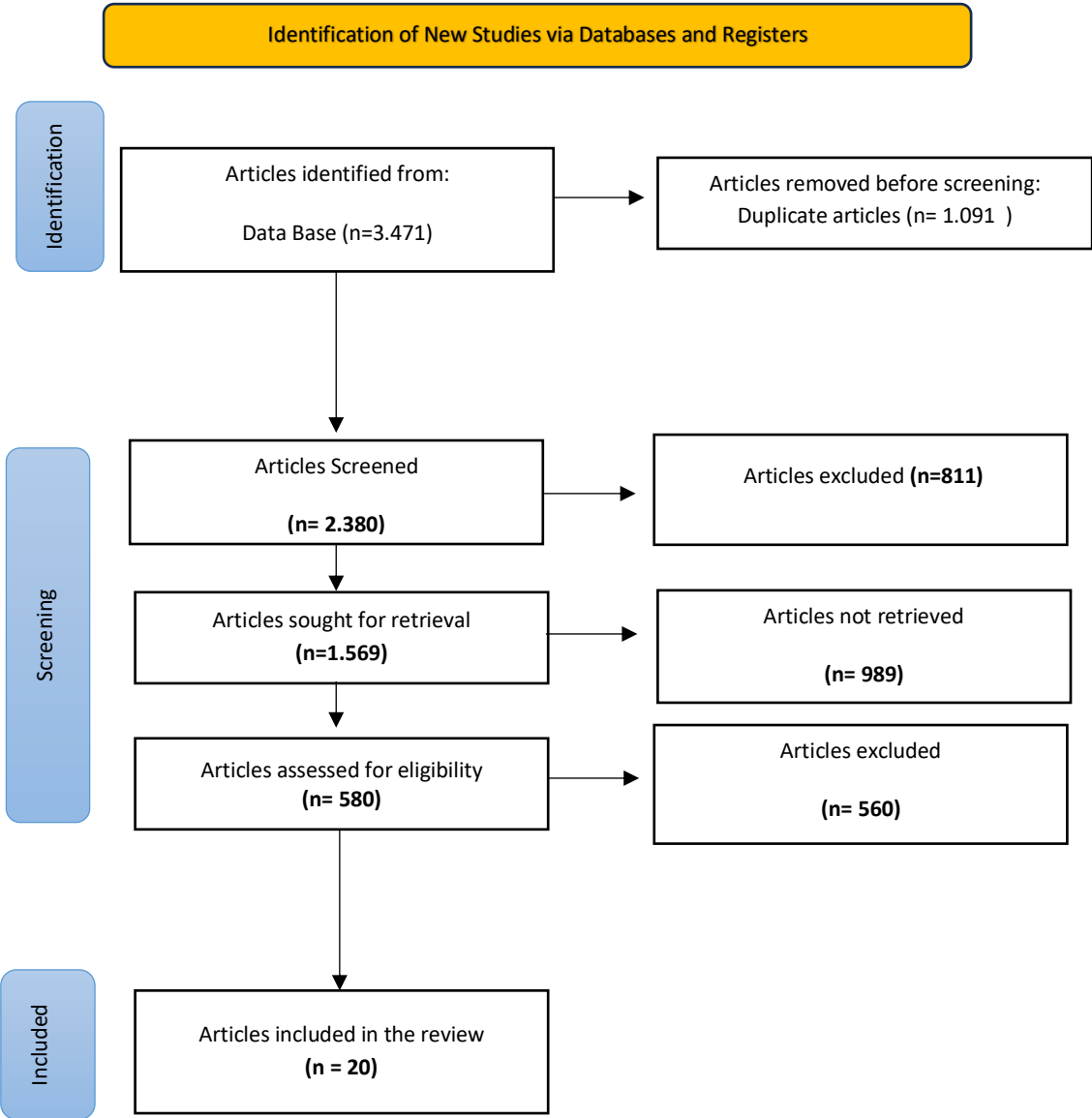


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow Diagram.

The articles were presented in a tabular format containing information such as the author’s name, year of publication, title, publisher, country of origin, and key findings. Data extracted from the journals that met the inclusion criteria were compiled into **Table 1**.

Table 1. Research Findings from Studies Included in the Systematic Review

No	Authors & Year	Population / Subjects	Troponin Type	Angiography / Imaging Method	Correlation /	Study Outcomes
1	Januzzi, J. L. Jr. (2019)	Patients with CAD undergoing CCTA	hs-cTnI	CCTA	$p < 0.001$	hs-cTnI was associated with coronary plaque burden and obstructive CAD
2	Samman Tahhan, A. (2018)	Stable CAD patients	hs-cTnI	ICA	$p < 0.001$	hs-cTnI increased with atherosclerosis progression
3	Tveit, S. H. (2022)	Patients with suspected CAD	hs-cTnI / hs-cTnT	ICA	$p < 0.001$	Linear association with CAD $\geq 50\%$ stenosis
4	Adamson, P. D. (2018)	Stable angina patients	hs-cTnI	ICA	$p < 0.001$	hs-cTnI served as an independent predictor of obstructive CAD
5	Danek et al. (2022)	Stable CAD patients	hs-cTn	ICA	$p = 0.002$	hs-cTn levels increased in patients with more complex CAD
6	Fatemi, A. (2023)	Patients undergoing ICA	hs-cTn	ICA	$p < 0.001$	Positive correlation between hs-cTn levels and CAD severity
7	Arslan et al. (2025)	Patients with acute chest pain	hs-cTnI	CCTA	$p < 0.05$	hs-cTn improved ACS risk stratification accuracy
8	McCarthy, C. (2023)	Low-risk chest pain patients	hs-cTn	ICA and downstream testing	$p < 0.05$	Implementation of hs-cTn reduced the need for invasive angiography
9	Han, E. (2025)	Patients with suspected AMI	hs-cTnI vs hs-cTnT	ICA	$p < 0.001$	hs-cTnI demonstrated higher positive predictive value
10	Wereski, R. (2023)	Chronic CAD patients	hs-cTnI	ICA	$p < 0.001$	hs-cTn correlated with CAD severity and prognosis
11	Lan, N. S. R. (2024)	Rural CAD patients	hs-cTn	ICA	$p < 0.001$	Even low hs-cTn levels predicted obstructive CAD

No	Authors & Year	Population / Subjects	Troponin Type	Angiography / Imaging Method	Correlation /	Study Outcomes
12	Cardoso, M. R. (2018)	Acute coronary syndrome patients	hs-cTn	ICA (SYNTAX/TIMI/G RACE scoring)	$p < 0.001$	hs-cTn correlated with coronary lesion complexity
13	Ferencik, M. (2016)	Patients with suspected ACS	hs-cTn	CCTA	$p < 0.001$	hs-cTn correlated with coronary plaque and CT markers
14	Agirbasli (2020)	NSTEMI patients	hs-cTnI	ICA	$p < 0.001$	hs-cTnI was associated with severe CAD
15	Bravo, C. (2024)	NSTEMI patients	hs-cTn	ICA	$p < 0.001$	Higher hs-cTn levels were associated with severe coronary stenosis
16	Strube, T. (2024)	Patients with moderate hs-cTn elevation	hs-cTn	CCTA vs ICA	$p < 0.05$	CCTA reduced the need for invasive angiography
17	Fujisawa et al. (2021)	Patients with suspected CAD	hs-cTn	CCTA	$p < 0.05$	Troponin-guided CT improved obstructive CAD detection
18	Nguyen, M. T. (2024)	Hospitalized patients with suspected CAD	hs-cTnT	ICA	NR	hs-cTn influenced clinical decision-making and angiography utilization
19	Leite, L. (2022)	CAD imaging studies	hs-cTn	CCTA and coronary calcium scoring	$p < 0.001$	hs-cTn correlated with subclinical atherosclerosis
20	Hui et al. (2021)	Biomarker and angiography dataset	hs-cTn	Angiography with AI modeling	AUC = 0.87	hs-cTn improved prediction accuracy for significant coronary stenosis

4. DISCUSSION

The present systematic review demonstrates a consistent positive association between high-sensitivity cardiac troponin (hs-cTn) levels and coronary angiography findings across multiple clinical settings. However, interpretation of these findings must consider the substantial heterogeneity among included studies, which may influence the magnitude and clinical relevance of the observed associations.

Heterogeneity of Study Populations

One of the major sources of heterogeneity lies in the variation of patient characteristics among the included studies. The reviewed literature involved diverse clinical populations, including patients with stable coronary artery disease, suspected acute coronary syndrome, chronic CAD, and NSTEMI. Studies such as Adamson and Samman Tahhan primarily evaluated stable CAD populations, while others, including Bravo and Cardoso, focused on acute coronary syndrome cohorts. Acute coronary syndrome patients tend to exhibit higher hs-cTn levels due to active myocardial injury, whereas stable CAD patients often demonstrate lower baseline elevations reflecting chronic subclinical myocardial damage. These differences in clinical presentation can influence the strength of correlation between hs-cTn and angiographic findings.⁶⁻⁹

Additionally, demographic variations such as differences in geographic settings, rural versus urban populations, and baseline cardiovascular risk profiles further contribute to heterogeneity. For example, Lan highlighted the predictive value of low-level hs-cTn elevations in rural populations, suggesting that baseline risk stratification may vary across healthcare settings.¹⁰

Variability in Troponin Assay Platforms

Another important source of heterogeneity is the variation in troponin assay types used across studies. Several studies specifically evaluated hs-cTnI, while others assessed hs-cTnT or both biomarkers simultaneously. For instance, Han reported that hs-cTnI demonstrated higher positive predictive value compared to hs-cTnT in detecting significant coronary artery disease. Differences in assay sensitivity, analytical thresholds, and detection limits may lead to variability in reported associations between troponin levels and angiographic severity.¹¹ Furthermore, the use of different cut-off values across institutions may influence diagnostic accuracy and clinical interpretation.

Differences in Coronary Artery Disease Definitions

The definition of significant coronary artery disease varied among studies, which represents another source of heterogeneity. Some studies defined CAD based on the presence of $\geq 50\%$ luminal stenosis, as reported by Tveit, while others focused on plaque burden or presence of obstructive lesions identified through coronary computed tomography angiography (CCTA), as described by Januzzi and Ferencik. These differences in diagnostic criteria can affect the comparability of results, as plaque burden detected by CCTA may represent earlier stages of atherosclerosis that do not necessarily correspond to obstructive disease.¹²⁻¹⁴

Variation in Angiographic Scoring Systems

Several studies used different angiographic scoring systems to quantify coronary lesion complexity and disease severity. Cardoso utilized established scoring systems such as SYNTAX, TIMI, and GRACE scores to evaluate lesion complexity, whereas other studies relied on qualitative or semi-quantitative angiographic assessments.⁹ The use of standardized scoring systems may provide more objective measurement of disease burden, but variation in scoring methods limits direct comparison across studies and may contribute to differences in reported correlations with hs-cTn levels.¹⁵⁻¹⁷

Influence of Confounding Factors

Beyond methodological heterogeneity, several confounding factors may independently influence hs-cTn levels and should be carefully considered when interpreting the association between troponin and coronary angiography findings.

Age represents one of the most significant confounding variables. As demonstrated by Agirbasli, McCarthy and Wereski, advancing age is associated with increased baseline hs-cTn levels, potentially due to age-related myocardial remodeling and increased prevalence of comorbidities. Consequently, elevated troponin levels in elderly patients may not always reflect acute coronary obstruction.^{18–20}

Renal dysfunction is another critical confounder. Reduced renal clearance can result in chronically elevated hs-cTn levels, even in the absence of acute coronary ischemia. This phenomenon may lead to overestimation of CAD severity if renal function is not adequately considered.^{21–23}

Chronic myocardial injury also contributes to persistent hs-cTn elevation. Conditions such as hypertensive heart disease, cardiomyopathy, and heart failure may cause ongoing myocardial cell turnover, leading to detectable troponin levels independent of acute coronary events. Similarly, demand ischemia, which occurs when myocardial oxygen demand exceeds supply without plaque rupture, may elevate hs-cTn levels and mimic obstructive CAD.²⁴

Furthermore, comorbid conditions such as diabetes mellitus, hypertension, and systemic inflammatory diseases can contribute to both coronary atherosclerosis and myocardial injury, thereby acting as potential confounders in the observed relationship between hs-cTn and angiographic findings.

Clinical Implications

Despite these sources of heterogeneity, the overall evidence consistently supports the role of hs-cTn as a valuable biomarker for identifying patients at higher risk of significant coronary artery disease. Several studies, including Arslan and Fujisawa, suggest that hs-cTn-guided imaging strategies may improve diagnostic efficiency and optimize patient selection for advanced imaging modalities such as CCTA or invasive coronary angiography.^{17,25} However, clinicians must interpret troponin elevations within the broader clinical context, considering patient characteristics and potential confounding factors.

5. CONCLUSIONS

This systematic review demonstrates that high-sensitivity cardiac troponin (hs-cTn) levels are consistently associated with coronary angiography findings across various clinical settings. Elevated hs-cTn concentrations tend to correlate with the presence, severity, and complexity of coronary artery disease. Additionally, several studies suggest that hs-cTn may support risk stratification and assist in guiding the selection of diagnostic imaging modalities, including coronary computed tomography angiography and invasive coronary angiography.

However, the findings of this review should be interpreted with caution. The included studies exhibit considerable heterogeneity in terms of patient populations, troponin assay types, definitions of coronary artery disease, and angiographic assessment methods. Furthermore, several confounding factors, including age, renal

dysfunction, chronic myocardial injury, demand ischemia, and comorbid cardiovascular conditions, may independently influence hs-cTn levels and potentially affect the observed associations.

Therefore, while hs-cTn appears to be a useful biomarker for identifying patients at increased risk of coronary artery disease, the current evidence primarily demonstrates correlation rather than causation. Further well-designed prospective studies with standardized diagnostic criteria and uniform troponin measurement protocols are needed to clarify the clinical utility of hs-cTn in predicting angiographic coronary disease severity.

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Conflict of Interest Statement:

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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