

Association of Early Rise of High-Sensitivity Cardiac Troponin I with Severity of Coronary Artery Disease in non-ST Elevation Myocardial Infarction Patients

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ABSTRACT

Objective: To determine the association of early rise of high-sensitivity cardiac troponin I (hs-cTnI) with the severity of coronary artery disease in non-ST elevation myocardial infarction (NSTEMI) patients.

Methodology: This cross-sectional study was conducted at the Cardiology Department, Fauji Foundation Hospital, Rawalpindi from June to November 2023. After obtaining informed written consent, 100 patients with NSTEMI presenting in the Emergency Department were enrolled using non-probability convenient sampling technique. Patients presenting with the signs and symptoms of coronary artery disease for at least 1 hour were preceded for electrocardiogram (ECG) and high-sensitivity cardiac troponin I levels. After initial management, the patients underwent coronary angiography either by trans-femoral or trans-radial approach. Severity of coronary artery disease was determined by SYNERGY between percutaneous with TAXUS and cardiac surgery (SYNTAX) score. The association of disease severity as determined by the SYNTAX score was seen with the hs-cTnI levels. Data was analyzed using Statistical Package for the Social Sciences (SPSS) version 25.

Results: The majority of the patients (50%) had SYNTAX score of 0-22 and 35% had score of 23-32. Only 15% of the patients had a SYNTAX score >33. A significant relation was found between the SYNTAX score and hs-cTnI. The level of high-sensitivity troponin I was increased significantly in patients with triple vessel disease.

Conclusion: High-sensitivity cardiac troponin I is a reliable marker of disease severity. A significant association exists between the severity of the disease as indicated by the SYNTAX score and levels of hs-troponin I in patients with NSTEMI. Patients with triple vessel disease are more likely to have higher hs-cardiac troponin I levels.

Keywords: Coronary artery disease. Troponin I. Non-ST elevation myocardial infarction.

INTRODUCTION

Coronary artery disease (CAD) is the most common among cardiovascular diseases (CVD), responsible for premature mortality. There is a 42% increase in trends of mortality from CVD since 1990. It also contributes to 180 million disability-adjusted life years.¹ Prevalence of coronary artery disease is high in Nepal, India, Afghanistan, Pakistan, Bhutan, Sri Lanka, Maldives, and Bangladesh. Coronary artery disease is classified into unstable angina, ST-elevation myocardial infarction (STEMI), and non-ST-elevation myocardial infarction. Around 70% of the cases of CAD are caused by NSTEMI. The underlying pathogenesis of NSTEMI involves the disruption of the balance between oxygen supply and cardiac oxygen requirement.² The chances of CAD are higher in advanced age, being a significant contributor to mortality. But nowadays, it also affects a considerable proportion of young individuals. The other predisposing factors are high blood pressure, diabetes mellitus, hypertension,

deranged lipid profile, overweight, smoking, and positive family history of ischemic heart disease.³ Myocardial infarction is characterized by a typical clinical picture, ECG changes, and a rise in cardiac troponin >99th percentile of the upper limit.⁴ Cardiac troponin (cTn) is present within the contractile apparatus of myocardial cells and after injury to the myocardium, it is released into the blood. Raised cardiac troponin is the key diagnostic modality for CAD. It has two types: cardiac troponin T (cTnT) and cardiac troponin I (cTnI). But it is also raised in some other diseases such as sepsis & adrenal insufficiency. The majority of the immunoassays available for cTn lack analytical sensitivity resulting in failure to detect cTn during the early phase of NSTEMI and in small infarcts. A relatively new type of troponin known as high-sensitivity cardiac troponin I is now being used due to its high sensitivity. It can measure 5-10 times lower concentration of cTnI.⁵ It has been reported that hs-cTnI is more sensitive as compared to hs-cTnT in CAD.⁶

Various scores are implied to assess the extent of the disease and its severity. Some scores also guide about the best treatment option on the basis of angiographic findings. They can also be used as a prognostic factor to monitor the disease.⁷ The SYNTAX score is a well-known aid used by cardiologists to assess the severity and extent of CAD. It is also a validated predictor of cardiovascular outcomes.⁸

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Received: April 21, 2024; Accepted: May 2, 2024

This study was done to determine the severity of coronary artery disease using the SYNTAX score in NSTEMI patients and see the association of levels of hs-cTnI with disease severity based on the SYNTAX score. This study will help in risk stratification and early recognition of patients with severe disease so that such patients can be referred for timely therapeutic intervention. It will also have clinical implications in disease prognosis and can be used to monitor for the occurrence of adverse outcomes.

METHODOLOGY

This cross-sectional study was conducted at the Cardiology Department, Fauji Foundation Hospital, Rawalpindi from June to November 2023. The study was approved by the ethical committee of the institution (Letter No. 748/RC/FFH/RWP, 02-05-2023). One hundred patients with NSTEMI presenting in the Emergency Department for at least 1 hour were enrolled regardless of their age or gender. Informed written consent was taken. The patients with unstable angina or STEMI were excluded. Sample size of 100 was calculated at 95% confidence interval with 9% margin of error using the prevalence of NSTEMI as 22.8% by the World Health Organization (WHO) sample size calculation.⁹ Patients with typical clinical manifestations of CAD were preceded by ECG and hs-cTnI levels. The patient's age, gender, comorbidities, type of disease, etc. were noted on the proforma. After initial management, the patients underwent coronary angiography either by transfemoral or trans-radial approach. The SYNTAX score of the patients was also estimated to determine disease severity. The higher the score, the more the severity of the disease.

The SYNTAX score estimates the severity and complexity of CAD on the basis of angiographic findings. It is calculated by adding points assigned to individual lesions with >50% stenosis in vessels with a caliber of >1.5 mm. It ranges from 0 to greater than 60. The SYNTAX score is divided into 3 categories; low: ≤ 22 , intermediate: 23-32, and high: ≥ 33 .¹⁰ The blood samples of patients were sent to the laboratory and hs-cardiac troponin I was estimated using the kit manufactured by Abbot Laboratories. The limit of detection of the kit was 1.2 ng/L. The upper limit used as a reference was 34 ng/L in males and 16 ng/L in females.¹¹ The association of disease severity as determined by the SYNTAX score was seen with the hs-cTnI levels.

STATISTICAL ANALYSIS

Data was analyzed using Statistical Package for the Social Sciences (SPSS) version 25. Mean & standard

deviation were calculated for quantitative variables such as age, hs-cTnI levels, and SYNTAX score. Qualitative variables like gender, type of disease, artery involved, etc. were represented using frequency and percentage. The Chi-square test was applied to determine the relation between the variables such as hs-cardiac troponin I levels and SYNTAX score. Association of hs-cTnI levels with type of coronary artery disease was also determined. A p-value of ≤ 0.05 was taken as significant.

RESULTS

The mean age of patients was 61.82 ± 8.94 years with a range of 43-80 years. Most of the patients [41(41%)] were between 51-60 years of age and 29(29%) patients were 61-70 years old. Eighty eight (88%) patients were females and only 12(12%) were males. Out of 100 patients, 68(68%) had both diabetes mellitus (DM) & hypertension (HTN), 20(20%) had only HTN, 2(2%) had DM, and 1(1%) was smoker. Thirty five (35%) patients had a positive family history of CAD.

The majority of the patients [36(36%)] had double vessel coronary artery disease (DVCAD), 32(32%) had triple vessel coronary artery disease (TVCAD) and 32(32%) had single vessel coronary artery disease (SVCAD). The left anterior descending artery (LAD) was involved in 50% followed by the left circumflex artery (LCX) in 21% and the right coronary artery (RCA) in 29% of the cases. The site of the lesion was proximal in 54%, middle in 15%, and distal in 31% of the patients. These results are tabulated in Table 1.

The mean SYNTAX score was 21.30 ± 8.56 with the range of 5 to 45. The majority of the patients (50%) had SYNTAX scores of 0-22 and 35% had score of 23-32. Only 15% of the patients had a SYNTAX score > 33 .

The mean hs-cTnI level was 24.68 ± 8.69 ng/L with a lowest level of 16.10 ng/L and maximum level of 40 ng/L. The mean hs-cTnI level in females was 20.70 ± 5.65 ng/L with a minimum level of 16.10 ng/L and maximum level of 30.60 ng/L. The mean hs-cTnI in males was 37.28 ± 2.11 ng/L ranging from 34.5 to 40 ng/L. A significant association existed between the disease severity indicated by the SYNTAX score and hs-cardiac troponin I levels. Patients with higher SYNTAX score had higher hs-cTnI levels (Table 2).

Similarly, a significant association was found between the type of disease (SVCAD, DVCAD, and TVCAD) and hs-cTnI levels. Patients with TVCAD had higher hs-cTnI levels as compared to patients with SVCAD and DVCAD (Table 3).

Table 1: Demographic Profile of the Study Participants

Variables		Descriptive Statistics
Age (Years)	Mean±SD	61.82±8.94
	41-50	10(10%)
	51-60	41(41%)
	61-70	29(29%)
	71-80	20(20%)
Gender	Male	12(12%)
	Female	88(88%)
Risk Factors	No Risk Factor	7(7%)
	HTN	20(20%)
	DM	2(2%)
	HTN & DM	68(68%)
	HTN & Smoking	1(1%)
	HTN & Obesity	1(1%)
	HTM, DM & Smoking	1(1%)
Family History of CAD	Positive	35(35%)
	Negative	65(65%)
Type of Disease	SVCAD	32(32%)
	DVCAD	36(36%)
	TVCAD	32(32%)
Artery Involved	LAD	50(50%)
	LCX	21(21%)
	RCA	29(29%)
Site of Lesion	Proximal	54(54%)
	Mid	15(15%)
	Distal	31(31%)

Table 2: Association of hs-cTnI Levels with the SYNTAX Score

hs-cTnI level (ng/L)		SYNTAX Score			Total	Chi-Square Statistic	p-value
		0-22	23-32	>33			
Females	<20	30(34.1%)	3(3.4%)	2(2.2%)	35(39.8%)	31.629	0.001*
	≥20	13(14.8%)	27(30.7%)	13(14.8%)	53(60.2%)		
	Total	43(48.9%)	30(34.1%)	15(17%)	88(100%)		
Males	<38	5(41.7%)	0(0%)	0(0%)	5(41.7%)	6.122	0.013*
	≥38	2(16.6%)	5(41.7%)	0(0%)	7(58.3%)		
	Total	7(58.3%)	5(41.7%)	0(0%)	12(100%)		

*Significant p-value

Table 3: Association of hs-cTnI Levels with the Type of Disease

hs-cTnI level (ng/L)		Type of Disease			Total	Chi-square Statistic	p-value
		SVCAD	DVCAD	TVCAD			
Females	<20	22(25%)	10(11.4%)	3(3.4%)	35(39.8%)	27.208	0.001*
	≥20	7(8%)	19(21.6%)	27(30.6%)	53(60.2%)		
	Total	29(33%)	29(33%)	30(34%)	88(100%)		
Males	<38	3(25%)	2(16.6%)	0(0%)	5(41.7%)	6.122	0.047*
	≥38	0(0%)	5(41.7%)	2(16.6%)	7(58.3%)		
	Total	3(25%)	7(58.3%)	2(16.6%)	12(100%)		

*Significant p-value

DISCUSSION

Higher levels of high-sensitivity cardiac troponin I are linked with CAD and increased chances of developing adverse outcomes such as recurrent episodes and cardiovascular mortality.¹² In this

study, a association between hs-TnT and the severity of coronary artery disease was observed.

In our study, 88% were females and 12% were males, the mean age being 61.82±8.94 years. On the contrary, in another study, the majority of the patients (73.4%) were males and only 26.5% were

females with a mean age of 59.35 ± 11.08 years.¹⁰ Ali et al. included 204 patients in their study. The mean age of the patients was 67.4 ± 14.5 years and 109(53.4%) patients were males.¹³ The average age was 60 years and 85% were males according to AbdelHamid et al.¹⁴ In our study, 68% of the patients had both DM & HTN, 20(20%) had only HTN, 2(2%) had DM and 1(1%) were smokers. Thirty five (35%) patients had a positive family history of CAD. According to Hasan et al., 50% of the cases were diabetic, 69.5% were hypertensive, and 63.9% had deranged lipid profiles. Around 28% of the patients were smokers and 22.2% had a positive history of CAD.¹⁰ According to another study, 70% of the patients were smokers and had deranged lipid profiles. Around 38% of the patients had HTN and DM. A family history of CAD was positive in 24% of the cases.¹⁴

In our study, the majority of the patients had DVCAD (36%), 32% had SVCAD, and 32% had TVCAD. In another study, TVCAD, DVCAD, and single vessel disease were seen in 26%, 20%, and 20% of the patients, respectively. Normal angiograms were seen in 11% of patients, whereas 23% had non-obstructive CAD.¹⁵ In our study, LAD was involved in 50% of the cases, LCX in 21%, and RCA in 29% of the cases. In another study, the artery predominantly involved was LAD (46.5%) followed by RCA (27.9%) and LCX (25.6%).¹⁴ In a study by Samman Tahhan et al., LAD was involved in most of the patients.¹⁵

Our results showed that the mean SYNTAX score was 21.30 ± 8.56 . Another study reported a mean SYNTAX score of 17.3.¹⁶ In another study, the average SYNTAX score was 16.5 ± 7.5 .¹⁵ Our study found a significant association between hs-troponin I levels and severity of disease, as indicated by SYNTAX score. Two other studies also revealed a positive link between hs-troponin I and SYNTAX score.^{17,18} Another study reported a weak significant association between hs-troponin I and SYNTAX score but this study enrolled all patients with acute coronary syndrome.¹⁹ Hasan et al. also reported a significant correlation between troponin I & SYNTAX score. But this relation was seen with troponin I, not hs-troponin I.¹⁰ A significant relation was seen between hs-TnI levels and severity of CAD in a study but the severity of disease was assessed by the Gensini score, instead of SYNTAX score used in our study.¹⁵ In contrast, no significant association was seen between SYNTAX score and hs-troponin I in a study by AbdelHamid et al. They enrolled both STEMI and NSTEMI patients rather than only patients with NSTEMI.¹⁴ The results of a

systematic review and meta-analysis revealed a positive relation between the severity of coronary artery disease and levels of hs-troponin I.²⁰

Our results showed that the hs-cardiac troponin I level also had a significant relation with the type of disease i.e. SVCAD, DVCAD & TVCAD. Patients with triple vessel disease had significantly high hs-cTnI levels as compared to double vessel CAD & single vessel CAD. In another study, patients with triple vessel disease had significantly higher hs-troponin I levels.¹⁵ Similar Hasan et al. also revealed a positive relation of TVCAD with hs-troponin I levels.¹⁰

CONCLUSION

High-sensitivity cardiac troponin I is a reliable marker of the severity of CAD. A significant association exists between the severity of disease as indicated by SYNTAX score and hs-cardiac troponin I levels in patients with NSTEMI. Patients with triple vessel disease are more likely to have higher hs-cardiac troponin I levels.

LIMITATIONS & RECOMMENDATIONS

This single-centered study was conducted at a tertiary care hospital. A multi-centered study should be conducted in the future. Follow-up of the patients was not done and the study did not evaluate the prevalence of adverse cardiac events in patients with elevated levels of hs-cardiac troponin I. Further study needs to be done to find out if patients with higher levels of hs-cardiac troponin I experience adverse cardiac events at follow-up. High-sensitivity cardiac troponin I should be employed instead of cardiac troponin I as a diagnostic aid in NSTEMI and to assess the severity of the disease.

Conflict of Interest: None.

Source of Funding: None.

Authors' Contributions:

W.M: Drafting the work

M.R: Conception or design of the work

A.H: Drafting the work

W.A.L: Analysis or interpretation of data for the work

W.H: Analysis or interpretation of data for the work

A.M: Final approval and article revisions

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