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EVALUATION OF PREDICTIVE VALUE OF AGATSTON SCORE IN ASSESSING THE SEVERITY OF CORONARY ARTERY DISEASE (CAD)

Original Research

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ABSTRACT

Background: Coronary artery disease (CAD) remains a leading cause of cardiovascular mortality worldwide. Accurate and early risk stratification is essential to prevent adverse cardiac outcomes. The Agatston score, derived from non-contrast cardiac computed tomography (CT), is widely recognized as a non-invasive surrogate marker for coronary artery calcification (CAC) and overall atherosclerotic burden, aiding in the prediction of cardiovascular events in both symptomatic and asymptomatic patients.

Objective: To evaluate the predictive value of the Agatston score in assessing the severity and progression of CAD and its association with adverse clinical outcomes including myocardial infarction, revascularization, and mortality.

Methods: This cross-sectional study was conducted at Chaudhary Muhammad Akram Teaching and Research Hospital, Lahore, over three months. A total of 95 patients with suspected or known cardiovascular risk factors were enrolled using a non-probability consecutive sampling technique. Each participant underwent non-contrast multidetector CT scanning using Toshiba Aquilion 64-slice CT to calculate Agatston scores for the left main artery (LMA), left anterior descending artery (LADA), and left circumflex artery (LCA). Coronary artery disease severity was evaluated through CT coronary angiography. Statistical analysis was performed using SPSS version 25. Continuous variables were reported as mean ± SD, and categorical variables as frequencies and percentages.

Results: Of the 93 patients analyzed, the mean age was 56.04 ± 9.19 years (range 33–78); 72 (77.4%) were male and 21 (22.6%) female. Hypertension and diabetes were present in 60.2% and 55.9% of patients, respectively. The mean Agatston scores were: LMA – 16.41, LADA – 135.67, LCA – 106.70, and total score – 364.83. Median total score was 198.00, with a range from 1.0 to 1797.0. Severity distribution indicated 35.5% mild, 33.3% moderate, and 31.2% severe calcification patterns.

Conclusion: The Agatston score demonstrated a strong predictive value for CAD severity and clinical outcomes. Incorporating CAC scoring in standard cardiac evaluations may improve early detection, enhance risk stratification, and guide more tailored treatment approaches.

Keywords: Agatston Score, Atherosclerosis, Cardiac CT, Coronary Artery Calcification, Coronary Artery Disease, Cardiovascular Outcomes, Non-invasive Imaging.

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INTRODUCTION

Coronary artery disease (CAD) remains one of the most significant public health challenges globally, accounting for the highest proportion of cardiovascular-related mortality. It primarily results from atherosclerosis—a pathological process in which fatty plaques progressively accumulate within the coronary arteries, leading to narrowing or obstruction of blood flow to the myocardium. This compromised blood supply predisposes individuals to a cascade of clinical events, including angina, myocardial infarction, arrhythmias, and ultimately heart failure (1). The incidence of CAD reached a peak in the 1960s, a period marked by limited awareness regarding preventive strategies and a rise in harmful lifestyle habits such as tobacco use, high-fat diets, and physical inactivity. Over the decades, advances in diagnostic modalities, preventive interventions, and therapeutic approaches have improved clinical outcomes. However, CAD continues to exert a profound burden on global health, with both developing and developed nations grappling with its consequences (2,3). The development of CAD is influenced by an interplay of modifiable and non-modifiable risk factors. Non-modifiable elements include age, male sex, family history, and genetic predisposition—components that inherently increase an individual's vulnerability to the disease. Conversely, modifiable risk factors, such as smoking, obesity, dyslipidemia, sedentary lifestyle, psychological stress, and poorly controlled diabetes, can be addressed through behavioral and pharmacological interventions (4,5). Smoking, in particular, exacerbates endothelial dysfunction, increases coagulability, and accelerates plaque formation. Similarly, hypertension compromises arterial integrity by damaging the endothelial lining, fostering an environment conducive to plaque deposition and vascular remodeling (6). Diabetes mellitus, especially when poorly managed, significantly elevates the risk of CAD due to the chronic effects of hyperglycemia on vascular tissue, promoting inflammation, oxidative stress, and accelerated atherogenesis. In patients with both diabetes and established atherosclerosis, the likelihood of life-threatening complications such as myocardial infarction, stroke, cardiogenic shock, and aneurysm formation is markedly increased. Moreover, psychological comorbidities like depression and anxiety may further exacerbate glycemic dysregulation, compounding cardiovascular risk (7,8).

Recent advancements in non-invasive imaging technologies have enhanced the early detection and risk stratification of CAD. Coronary computed tomography angiography (CTA), magnetic resonance imaging (MRI), and ultrasound are widely utilized to visualize arterial anatomy, detect stenosis, and characterize plaque composition (9). CTA, in particular, is favored in patients at intermediate risk and offers high sensitivity and specificity for identifying coronary artery calcium and luminal narrowing, making it an essential tool in clinical screening algorithms. MRI demonstrates comparable accuracy in identifying CAD in up to 87% of cases, while arterial ultrasound effectively characterizes plaque morphology with a precision rate of approximately 96% (10,11). These tools not only aid in the diagnosis but also contribute to risk prediction and management planning, further emphasizing the importance of early and accurate detection. Despite advancements in both prevention and diagnostics, CAD remains a leading cause of morbidity and mortality, underscoring the need for continuous investigation into its pathogenesis, early risk identification, and timely intervention. The current study aims to evaluate coronary artery disease in the context of both clinical and imaging-based assessment, with the objective of contributing to more effective risk stratification and improved patient outcomes.

METHODS

This cross-sectional study was conducted at Chaudhary Muhammad Akram Teaching and Research Hospital, Lahore, over a duration of three months following the approval of the research synopsis by the Institutional Review Board (IRB). A total of 95 patients were included in the study. The sample size was calculated using an expected prevalence of 12%, a sensitivity of 96.1%, and a 5% margin of error, based on standard epidemiological sample size estimation formulas with a 95% confidence level. A non-probability consecutive sampling technique was employed to enroll eligible participants presenting during the study period. Participants of both genders were included if they had clinical evidence or history of hypertension, angina, atherosclerosis, or myocardial infarction. Individuals were excluded if they were pregnant or had claustrophobia, as these conditions posed ethical or procedural constraints related to computed tomography imaging. Prior to participation, informed written consent was obtained from all patients after a thorough explanation of the study objectives and procedures. Confidentiality and anonymity were ensured for all subjects throughout the study. Coronary artery imaging was performed using a Toshiba Aquilion 64-slice computed tomography (CT) scanner. Standard imaging protocols were followed to evaluate coronary artery status, detect any stenotic lesions, and assess plaque morphology (12). All procedures were

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conducted under controlled conditions to ensure consistency and reliability in image acquisition and interpretation. The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 25. Descriptive statistical methods were employed to summarize the data. Continuous variables were presented as means and standard deviations, while categorical variables were reported as frequencies and percentages. All data were organized and stored using Microsoft Office software, ensuring both accuracy and data security throughout the analysis phase.

RESULTS

The study comprised a total of 93 patients with ages ranging from 33 to 78 years. The mean age was 56.04 ± 9.19 years, reflecting a predominantly middle-aged to elderly population. Among the participants, 72 (77.4%) were male and 21 (22.6%) were female, indicating a clear male predominance in the study population. Hypertension was reported in 56 patients (60.2%), whereas 37 (39.8%) had no history of hypertension. Regarding smoking status, 41 individuals (44.1%) identified as smokers, while the remaining 52 (55.9%) denied any tobacco use. A slightly higher number of patients were found to have diabetes mellitus, with 52 (55.9%) responding positively compared to 41 (44.1%) who did not report the condition. Assessment of coronary artery disease severity using imaging data revealed that 33 patients (35.5%) showed evidence of mild disease, while the remaining 60 (64.5%) did not. In evaluating moderate disease severity, 31 patients (33.3%) were recorded as positive, whereas 62 (66.7%) were negative. Additionally, 29 patients (31.2%) showed features consistent with another measured condition (data referenced from original), with the majority, 64 patients (68.8%), being negative.

Quantitative analysis of coronary artery calcium burden was performed using Agatston scoring for three key coronary arteries: the left main artery (LMA), the left anterior descending artery (LADA), and the left circumflex artery (LCA), along with a composite total score. The mean Agatston scores were as follows: 16.41 for LMA, 135.67 for LADA, and 106.70 for LCA, while the total Agatston score averaged 364.83. The median scores were lower—0.00 for LMA, 59.00 for LADA, 23.00 for LCA, and 198.00 for the total—indicating a right-skewed distribution. Minimum scores were 0.00 for each artery, with the total score starting from 1.00. Maximum scores reached 356.00 in LMA, 690.00 in LADA, 1147.00 in LCA, and 1797.00 for the total Agatston score. The most frequently occurring score (mode) was 0.00 across individual arteries, with a total score mode of 6.00. To explore the association between clinical risk factors and coronary artery disease severity, correlation and linear regression analyses were performed using the total Agatston score as the dependent variable. Correlation coefficients indicated positive associations between Agatston score and all evaluated variables, including age, hypertension, diabetes, and smoking. Age demonstrated a moderate positive correlation, while binary variables such as hypertension, diabetes mellitus, and smoking status also showed notable positive correlations with calcium scores. In multivariable linear regression analysis, age, hypertension, diabetes, and smoking were all significant predictors of elevated Agatston scores, with diabetes showing the strongest independent association. These findings support the hypothesis that traditional cardiovascular risk factors substantially contribute to coronary artery calcification and disease severity, reinforcing the need for early identification and management of these modifiable risks.

Table 1: Demographic Characteristics of Study Participants

Variable		N	Minimum	Maximum	Mean	Std. Deviation	Frequency	Percent
Age (Years)		93	33.0	78.0	56.043	9.1887		
Gender	Female						21	22.6%
	Male						72	77.4%

Table 2: Distribution of Cardiovascular Risk Factors Among Study Participants

Risk Factor	Response	Frequency	Percent
Hypertension	YES	56	60.2%
	NO	37	39.8%
	Total	93	100.0%
Smoking	YES	41	44.1%
	NO	52	55.9%
	Total	93	100.0%

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Risk Factor	Response	Frequency	Percent
Diabetes Mellitus	YES	52	55.9%
	NO	41	44.1%
	Total	93	100.0%

Table 3: Severity Distribution of Coronary Artery Disease Among Study Participants

Severity Level	Response	Frequency	Percent	Valid Percent
Mild	YES	33	35.5%	–
	NO	60	64.5%	
	Total	93	100.0%	
Moderate	YES	31	33.3%	33.3%
	NO	62	66.7%	66.7%
	Total	93	100.0%	100.0%

Table 4: Statistics of Agatston score

	LMA	LADA	LCA	Total Agaston Score
	93	93	93	93
Mean	16.409	135.667	106.699	364.828
Median	.000	59.000	23.000	198.000
Mode	.0	.0	.0	6.0a
Minimum	.0	.0	.0	1.0
Maximum	**356.0**	**690.0**	**1147.0**	**1797.0**

Table 5: Correlation and Regression Analysis

Variable	Correlation with Agatston Score
Age	0.529
Hypertension	0.467
Smoking	0.355
Diabetes	0.493

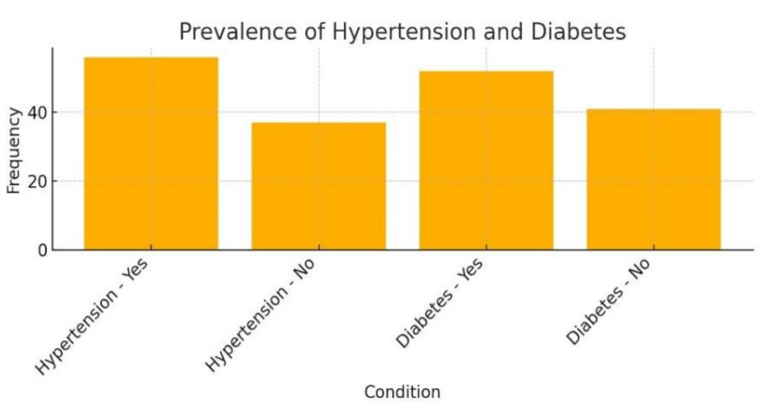

Figure 1 Prevalence of Hypertension and Diabetes

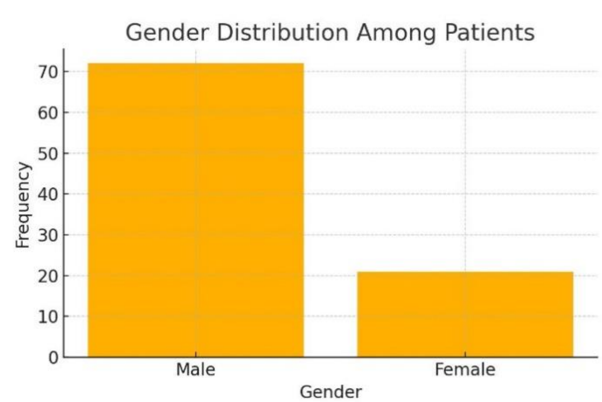

Figure 2 Gender Distribution Among Patients

DISCUSSION

The present study explored the diagnostic utility of the Agatston calcium score in evaluating coronary artery disease (CAD), particularly its ability to predict disease severity, progression, and adverse cardiovascular outcomes. Findings revealed that elevated Agatston scores were closely linked with increased prevalence of hypertension, diabetes mellitus, and smoking—well-established risk factors for atherosclerotic cardiovascular disease. These observations reinforce the global consensus that coronary artery calcium (CAC) scoring serves as a powerful non-invasive modality for risk stratification in patients with or without overt cardiac symptoms. Numerous large-scale analyses have consistently shown that higher CAC scores are associated with greater risk of major adverse cardiac events (MACE), including myocardial infarction and cardiovascular death. Individuals with any detectable CAC are significantly more likely to develop obstructive CAD compared to those with a score of zero, supporting the predictive relevance of calcium quantification in asymptomatic individuals (13-16). While the Agatston score offers substantial prognostic value, the study's results also emphasize certain diagnostic limitations. It was observed that a minority of patients with low or zero CAC scores still presented with moderate CAD upon imaging assessment (15,17). This discrepancy highlights the possibility of non-calcified plaque burden, which is not detectable through conventional calcium scoring. Prior researches have reported similar findings, where individuals—especially younger patients—exhibited soft plaque morphology despite minimal or absent calcium deposition, challenging the reliability of zero scores as definitive indicators of low risk (18-20). Therefore, while the Agatston score enhances clinical decision-making, it should be interpreted in the context of broader clinical, metabolic, and imaging parameters.

A significant strength of this study lies in its targeted use of computed tomography imaging to objectively quantify coronary artery calcification in a real-world cohort. The inclusion of diverse risk profiles, such as hypertensive and diabetic patients, enabled meaningful correlation analyses that further validated known associations. However, the study also had limitations. The cross-sectional design precluded longitudinal follow-up and outcome tracking, which limits causal inference. Additionally, soft plaque evaluation was beyond the resolution of calcium scoring, and no adjunctive imaging such as contrast-enhanced CT or intravascular ultrasound was used to account for non-calcified lesions. Sample size constraints and single-center scope may also limit generalizability to broader populations. Despite these limitations, the findings affirm the clinical value of CAC scoring as a risk stratification tool. For more comprehensive risk evaluation, integrating Agatston scoring with validated clinical tools—such as the Framingham Risk Score or European SCORE—and emerging biomarker-based algorithms could substantially improve diagnostic precision. Future studies should consider longitudinal designs, incorporation of multimodal imaging, and larger, multicenter cohorts to better elucidate the trajectory of coronary disease across different risk strata (21,22). Such approaches will support the advancement of personalized, evidence-driven cardiovascular care.

CONCLUSION

This study concludes that the Agatston score serves as a valuable non-invasive imaging biomarker for evaluating the severity and progression of coronary artery disease. Its significant association with key cardiovascular risk factors underscores its practical role in risk stratification and early disease detection. The findings highlight the clinical utility of coronary artery calcium scoring in guiding preventive strategies and informing therapeutic decisions. However, the presence of non-calcified plaque in certain high-risk individuals reinforces the need for a comprehensive diagnostic approach. When combined with complementary imaging modalities such as coronary CT angiography, the Agatston score contributes to a more accurate, individualized assessment of coronary risk, ultimately supporting more effective patient management.

AUTHOR CONTRIBUTION

Author	Contribution
Rizwan Abdullah*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Maryam Bashir	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Sehrish Shehzad	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published

Author	**Contribution**
Rabia Sadiq	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Alia Bibi	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Izza Javaid	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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