A Comparative Study of Conventional Coronary Artery Disease Risk Models and Coronary CT Angiography in a Tertiary Care Hospital

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Abstract

Background: Coronary artery disease (CAD) has continued to pose a significant morbidity and mortality burden the world over with a rising burden in India because of lifestyle and genetic causes. Conventional risk prediction systems e.g., Framingham Risk Score (FRS) are widely employed yet they may not encompass the aspect of regional differences in disease patterns. Coronary Computed Tomography Angiography (CCTA) can provide a direct anatomical determination of coronary atherosclerosis and can improve predictive accuracy.

Aim: To determine the correlation of traditional CAD risk models and CCTA results in order to predict diseases better and risk stratifications.

Methodology: A comparative descriptive study was carried out at Central Hospital, South Eastern Railway, Kolkata, in the sample of 110 patients aged 30-79 years with possible anginal chest pain. Demographic, clinical, and biochemical parameters data were gathered. FRS and NCEP ATP III results were determined and correlated with the CCTA based indices, such as Coronary Artery Calcium Score (CACS), Segment Involvement Score (SIS), Segment Stenosis Score (SSS), and Modified Duke's Prognostic Index (MDPI).

Results: Strong positive correlations were observed between FRS and CCTA indices (SIS, SSS, and MDPI, $r = 1.00$, $p < 0.001$) and between CACS and these indices ($r = 0.94$–0.95, $p < 0.05$).

Conclusion: CCTA demonstrated superior diagnostic value by correlating strongly with traditional risk scores and providing precise anatomical assessment, supporting its role as a complementary tool for CAD risk evaluation in the Indian population.

Keywords: Coronary artery disease, Framingham Risk Score, Coronary CT angiography, Coronary calcium score, Risk stratification.

1. Introduction

Coronary artery disease (CAD), a significant contributor of global mortality, is a major disease within the larger construct of cardiovascular disease (CVD). CAD is characterized by the accumulation of atherosclerotic plaques in the coronary arteries leading to reduced blood flow to the myocardium. The burden of CAD has progressed rapidly in developing nations, especially India, as CAD has been reported to occur at a younger age and more severe disease. Factors such as genetic predisposition, lifestyle including sedentary living, diets high in saturated fat and processed carbohydrates, smoking, hypertension, and diabetes have contributed to this growing trend [1]. Together, each of these groups of factors offers a unique risk vector or risk profile specific to the Indian population, warranting the recognition of these risk factors in a region or specific population.

There are numerous traditional risk prediction models that can assess an individual's risk for developing CAD and guide prevention efforts. Traditional risk models, including the Framingham Risk Score (FRS), ACC/AHA ASCVD Risk Score, QRISK3, and GRACE score, consider a variety of factors such as age, blood pressure, cholesterols, smoking, and diabetes [2]. While these models allow for acceptable risk estimates in Western societies, the models may not reflect the broader risk classes of Indian cases due to the novel genetic, cultural and environments factors. Thus, it is warranted to assess the established performance and applicability of traditional models for the prediction of disease and disease management in Indian populations.

Recently, imaging modalities have made Coronary Computed Tomography Angiography (CCTA), an alternative way to evaluate or diagnosis having coronary artery disease (CAD). CCTA diverges from the traditional models of diagnosis based on clinical risk factors, because it evaluates the coronary arteries for obstructive and non-obstructive plaques. The CCTA also provides extensive plaque burden and composition information, to help clarify higher risk populations prior to any symptoms. As the CCTA develops more as an assessment tool, it may possess added benefits compared to clinical risk factor-based assessments in terms of detection and assessment in clinical setting [3]. An important approach to evaluate risk or severity of disease for patients in a population in India is to examine to traditional scores or other models that have been validated independent or equivalently accurate.

Considering the advancements in this area, this study was developed to compare traditional coronary artery disease risk models using coronary CT angiography outcomes from a tertiary care hospital. The study will examine whether traditional cardiovascular risk scores correlate with the anatomical severity of CAD as determined by coronary CT angiography [4]. The study's objective is to evaluate the ability for traditional risk scores to predict disease burden, and if imaging adds incremental diagnostic and prognostic value.

Additionally, the study will assess the ability of these risk scores to predict outcomes in different demographic and clinical subgroups in the Indian population. Characteristics such as age, gender, metabolic syndrome incidence, and lifestyle behavior, can also all impact biochemical risk markers and imaging characteristics [5]. It may also help identify gaps in existing prediction tools in determining risk using risk scores versus angiographic findings, as well as the need for risk assessment tools to identify and assess risk on Indian population.

The research sets out to develop a complete framework for CAD risk assessment through a systematic comparison of methodologies. Traditional scoring systems remain simple to construct and inexpensive, but they may fail to account for the intricate relationship of emergent risk factors chronic inflammation, psychosocial stress, and genetic polymorphisms recognized in 21st century cardiology [6]. CCTA, on the other hand, although requiring a dedicated magnetic resonance imaging (MRI) machine and is more expensive, has the potential to be a robust diagnostic tool for accurate, early detection, particularly for asymptomatic or borderline-risk patients.

In conclusion, the outcomes of this comparison study have implications for clinical decision making and prevention strategies. By combining both the standard predictive models and the new imaging information, clinician's ability to develop better risk stratification will lead to more specifically targeted interventions and ultimately result in more individualized treatment plans and clinical outcomes. In a country like India where cardiovascular disease continues to present a heavy health and economic burden, health care practitioners developing a hybrid model of clinical prediction tools and diagnostic imaging evidence may be the next important step in moving CAD prevention and primary management forward both at the individual and population level.

2. Methodology

2.1. Study Design

This study was conducted as a comparative descriptive study to assess the correlation between conventional coronary artery disease (CAD) risk models and coronary computed tomography angiography (CCTA) findings in a tertiary care hospital setting.

2.2. Study Setting

The study was carried out in the Department of Medicine and Cardiology at Central Hospital, South Eastern Railway, Kolkata.

2.3. Study Population

The study included all patients admitted with suspected anginal chest pain in the Medicine and Cardiology wards, who were planned to undergo CT coronary angiography at Central Hospital, South Eastern Railway, Kolkata.

2.4. Study Duration

The study was carried out over a continuous period of two years, allowing for comprehensive data collection and analysis across diverse patient presentations and seasonal variations.

2.5. Sample Size Calculation

The sample size was determined based on the prevalence of coronary artery disease (CAD) of 12.5%, as reported in a study conducted by M. N. Krishnan et al. in Kerala, South India. The following formula was used to calculate the required sample size:

$$n = \frac{Z_{\alpha}^{2} \times p \times q}{e^{2}}$$

Where:

- p = 12.5% (0.125) (prevalence rate of CAD)
- q = (1 - p) = 0.875
- e = 7% (0.07) (margin of error)

• $Z\alpha = 1.96$ (value of standard normal variate at 5% error)

Substituting the values:

$$n = \frac{(1.96)^2 \times 0.125 \times 0.875}{e^2} = 98$$

Considering a 10% dropout rate, the final sample size was adjusted to 110 patients.

2.6. Inclusion and Exclusion Criteria

➢ **Inclusion Criteria**

Patients who met the following criteria were included in the study:

- Patients admitted with suspected anginal chest pain.
- Patients aged 30–79 years (as Framingham Risk Score is valid for this age group).
- Patients with eGFR >30 mL/min/1.73 m² (since non-ionic water-soluble contrast was
- used).

➢ **Exclusion Criteria**

Patients with the following conditions were excluded:

- Acute Myocardial Infarction (AMI) (patients with ECG ST-T changes and positive Troponin-T test).
- History of Percutaneous Transluminal Coronary Angioplasty (PTCA).
- History of Coronary Artery Bypass Grafting (CABG) or coronary stenting.
- Pregnant women.
- Chronic Kidney Disease (CKD) with eGFR < 30 mL/min/1.73 m².
- Previous history of contrast allergy.

2.7. Sampling Strategy

All patients fulfilling the inclusion criteria and providing informed consent were recruited for the study. Patients were enrolled consecutively to minimize selection bias.

2.8. Method of Data Collection

All eligible patients were well informed before joining the study of the nature, purpose and the possible benefits of the study. All the participants were given an elaborate description of the procedures of the study, and informed consent was written down according to the ethical principles of a research. They also assured the participants that they had the freedom of opting out of the research at any point without any negative effects to their current medical care and the treatment regimen.

A structured case record form that was specifically designed to collect the data was used in the study. The data obtained covered demographics, including age, sex, and occupation, along with a full medical history with a focus on established cardiovascular risk factors including hypertension, diabetes mellitus, smoking status, dyslipidemia, and obesity and a family history of coronary artery disease (CAD). All participants were examined physically to record the pertinent clinical findings.

Moreover, the Framingham Risk Score (FRS), NCEP ATP III risk classification of each patient were computed in order to identify individual cardiovascular risk profiles. The parameters of imaging using Coronary Computed Tomography Angiography (CCTA) were the coronary calcium score, segment involvement score, segment plaque score, segment stenosis score and the Modified Duke Prognostic Index. These variables were carefully noted down which were subsequently analyzed to derive correlations between conventional CAD risk models and imaging results.

2.9. Patient Preparation for CCTA

Every patient was advised to fast at least four hours before administering coronary computed tomography angiography (CCTA). At least twelve hours prior to the procedure, caffeinated drinks were avoided strictly so that the heart rate is not increased to influence the quality of the images. It was fully shaved down to the chest to allow basic electrocardiographic (ECG) leads to be placed and to obtain true leads. Achievement of a stable heart rate, and optimum image resolution was done by ensuring that the patients were given Tablet Metoprolol 50mg by mouth one hour prior to the scan. Also, participants were trained to do 15-second breath holding when taking an image to reduce respiratory motion artifact and to increase the clarity of the images.

2.10. Equipment and Instruments Used

The research involved the use of the state of the art cardiac imaging and monitoring equipment to guarantee accuracy and consistency in data collection. The Ivy BIOMEDical 7800 four-lead automated ECG machine was used in continuously monitoring heart rate. The contrast was administered via a 18-gauge IV cannula that was placed into an antecubital vein. An injected rate was maintained with the use of Injectasert to deliver the contrast medium. In every patient, 80 mL of CONTRAPAaque 350 (non-ionic, water-soluble contrast agent) was given, and the contrast agent was chased with 40 ml of saline, to facilitate a complete vascular opacification. Every procedure of coronary CT angiography was done with the use of 128-slice CT, which gave high-resolution volumetric images of the coronary vascularity (GE Medical Systems).

2.11. CCTA Image Acquisition and Analysis

Agatston scoring method was used to determine coronary artery calcium scoring (CACS), and is a quantitative measure of the burden of calcified plaque. Multiple validated indices were used to assess the overall coronary plaque load including the Segment Involvement Score (SIS) on a 0-16 scale, Segment Plaque Score (SPS) on a 0-48 scale and Segment Stenosis Score (SSS) on a 0-70 scale to grade luminal narrowing between less than 30, 30-49, 50-69, and 70 stenosis. The extent of coronary artery disease was assessed prognostically through the Modified Duke Index (MDPI) which combines anatomic and stenotic data to assess the overall risk.

2.12. Data Analysis

The acquired data underwent descriptive and inferential statistical analysis to come up with meaningful conclusions. Continuous variables, including age, serum lipid, and calcium levels scores, were presented in mean ± SD; meanwhile, categorical variables, including the presence of risk factors, and CAD severity levels were presented in frequencies and percentages. To be able to compare them, the Pearson correlation coefficient was utilized to find out the correlation between Framingham Risk Scores, NCEP ATP III risk categories, and CCTA-derived indices. The comparison of the categorical variables was done by the chi-square tests, and the continuous variables were compared by Student t-tests. Besides, multivariate logistic regression analysis was conducted to determine independent predictors of CAD regarding conventional risk factors and CCTA parameters. The p-value of 0.05 and below was considered to be statistically significant.

2.13. Ethical Considerations

Ahead of data collection, ethical clearance of the study was sought and received through the Institutional Ethics Committee. Informed consent was received in written form, and the personal and clinical data of all the participants were kept in their strict confidence. All new study findings or changes were communicated to the participants in order to ensure that they were aware of them and this might alter their participation. Notably, the study did not impose any financial pressure on a patient to take part in the study or undertake diagnostic studies to support the study.

3. Result

Table 1 presents the age analysis of study participants and has indicated that a substantial percentage of the study participants were in the age bracket of 50 to 59 years, (15 out of 35). This was succeeded by the participants between 60 and 69 years who were 25 percent. The group of 40-49 years old formed 20 percent of the respondents with the group of less than 40 years old forming 10 percent and the group of more than 70 years old forming 10 percent. In general, the statistical data indicate that the majority of the study population consisted of middle-aged and early elderly individuals.

Table 1: Age Distribution of Study Participants

Age Group (Years)	Percentage (%)
< 40	10
40–49	20
50–59	35
60–69	25
≥ 70	10

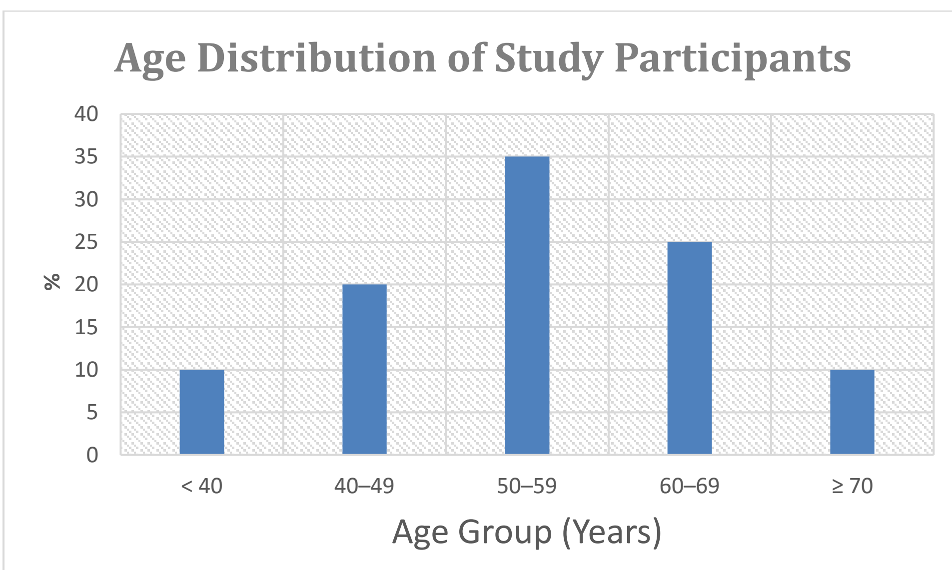

Figure 1: Age Distribution of Study Participants

Table 2 shows the gender distribution of the participants in the study with a majority being male, which makes up the 65 percent of the total participants and females constituting the remaining 35 percent of the total population. This imbalance implies a higher number of men as the subjects of the study, which can be explained by an increased prevalence of the disease, a higher propensity of male patients to seek healthcare, or some peculiarities of the sample used in the study.

Table 2: Gender Distribution of Study Participants

Gender	Percentage (%)
Male	65
Female	35

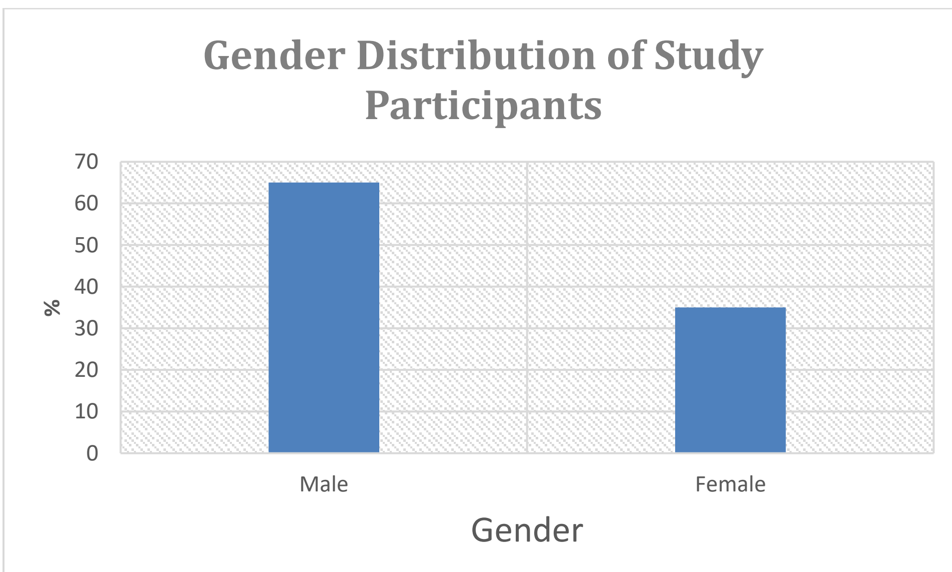

Figure 2: Gender Distribution of Study Participants

Table 3 presents the prevalence of the key risk factors among the participants of the study, with a clear prevalence of conditions that may be typically related to cardiovascular and metabolic disorders. The most common risk factor was hypertension (55% of the sample), then there was hyperlipidemia with 50 percent. Obesity characteristics of a BMI 25 and over were seen in 40 percent, and diabetes mellitus occurred in 35 percent of the subjects. The proportion of those who reported smoking was 30% which showed a relatively low but significant behavioral risk factor.

In general, the results indicate that a sizeable percentage of the population of the study was marred with numerous interacting risk factors that might lead to a rise in cardiovascular morbidity.

Table 3: Distribution of Risk Factors among Study Participants

Risk Factor	Percentage (%)
Hypertension	55
Diabetes Mellitus	35
Hyperlipidemia	50
Smoking	30
Obesity (BMI ≥ 25)	40

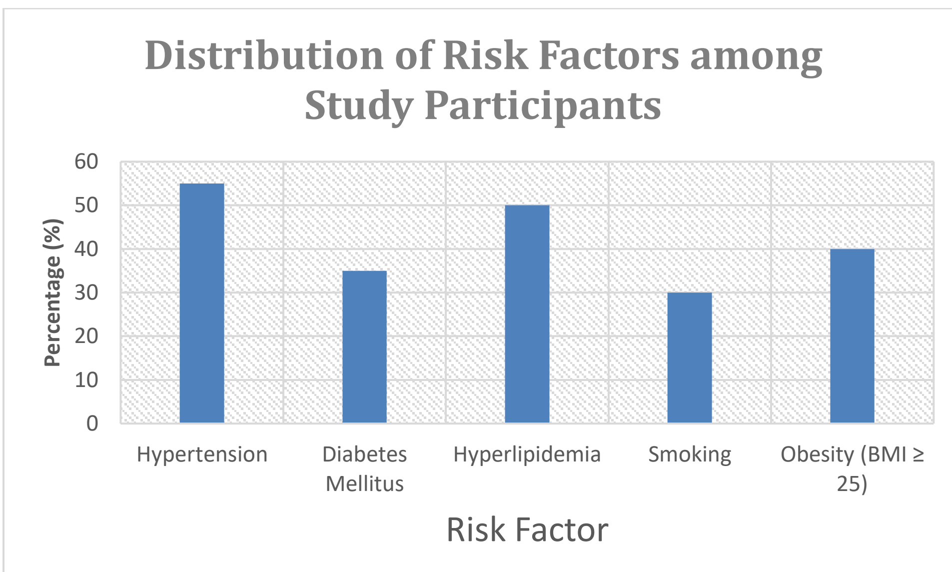

Figure 3: Distribution of Risk Factors among Study Participants

Table 4 shows how the participants were distributed according to the Framingham Risk Score (FRS). It was noted that a half of the study population (50%Of the whole population) was in the intermediate risk category implying a moderate likelihood of developing cardiovascular disease in the next ten years. In the meantime, 25% of the participants were assigned to the low-risk category, indicating a relatively low risk of cardiovascular events, and an equal number (25) was assigned to the high-risk one, indicating a considerably high risk. This distribution pattern shows that a large percentage of the study population is at moderate to high risk and it is dangerous that preventive measures and lifestyle changes should be introduced to minimize the future cardiovascular complications.

Table 4: Distribution of Participants According to Framingham Risk Score Categories	
Risk Category	**Percentage (%)**
Low (<10%)	25
Intermediate (10–20%)	50
High (>20%)	25

Table 5 shows the distribution of the participants as per Coronary Artery Calcium Score (CACS). The findings show that the proportion of participants with CACS values of 101400 Agatston units is 30, which included the greatest number of participants with moderate levels of calcification. Approximately a quarter of the respondents were in the 11100 range and this is considered mild calcification, and one fifth of all respondents had a score of 0, which is interpreted as none of the corrosive calcium detected and therefore a low risk of atherosclerosis. The lower percent of 15% scored 1-10 which means a very mild presence of plaque. The proportion of participants that scored above 400 was only 10 percent, indicating the presence of a high level of calcification and a high risk of developing coronary artery disease. In general, the statistics indicate that most of the participants were characterized by the presence of coronary calcification, with moderate values being most common.

Table 5: Distribution of Participants According to Coronary Artery Calcium Score (CACS)	
CACS Range (Agatston Units)	**Percentage (%)**
0	20
1–10	15

11–100	25
101–400	30
>400	10

Table 6 shows a breakup of the severity of coronary artery stenosis which had been determined using CCTA findings. It demonstrates that 40 percent of the participants had minimal stenosis (<30) which represents a substantially preserved coronary lumen on a considerable number of cases. One-fifth of the subjects had mild stenosis (30-49), with 20% having moderate stenosis (50-69). The 15% of the rest showed severe stenosis (≥70%), but they are the high-risk group of serious coronary obstruction. In general, these results indicate that the majority of the subjects experienced slight to severe constriction of the coronary arteries, and a smaller but significant percentage of them exhibited a clinically significant stenosis.

Table 6: CCTA Findings Showing Degree of Coronary Artery Stenosis

Stenosis Severity	**Percentage (%)**
<30% (Minimal)	40
30–49% (Mild)	25
50–69% (Moderate)	20
≥70% (Severe)	15

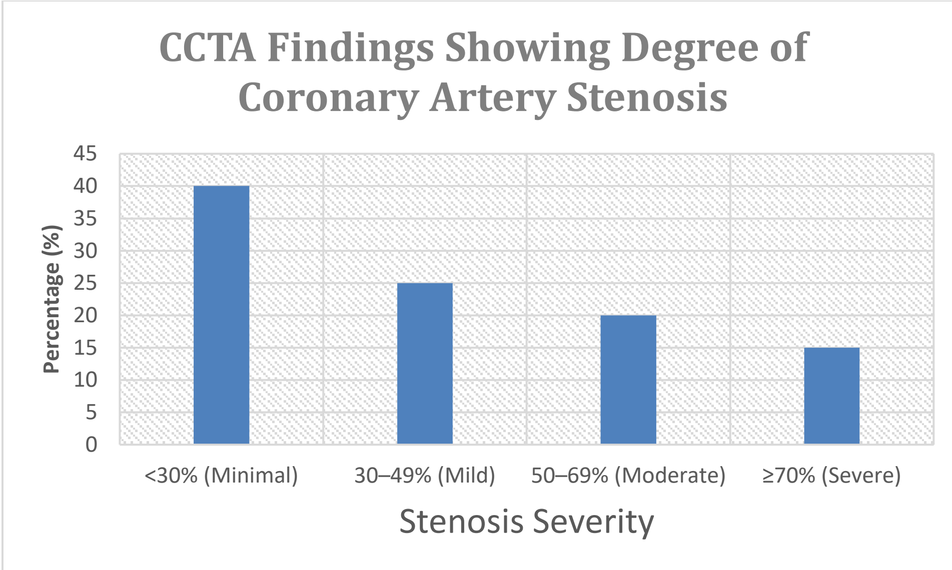

Figure 6: CCTA Findings Showing Degree of Coronary Artery Stenosis

Table 7 shows the distribution of the participants based on the Modified Duke Prognostic Index (MDPI). The results show that the most significant percentage of people (40) had the Duke 1 group (mildly stenosed), and 30 per cent of the respondents had no stenosis (Duke 0). Twenty percent of the population had moderate stenosis (Duke 23), and only ten percent of the population had severe stenosis (Duke 46). This distribution indicates that most of the participants either had no or mild coronary involvement with less cases having moderate to severe disease implying a relatively low overall burden of stenotic progression in the study population.

Table 7: Modified Duke's Prognostic Index (MDPI) Distribution

MDPI Category	Percentage (%)
Duke 0 (No Stenosis)	30
Duke 1 (Mild)	40
Duke 2–3 (Moderate)	20
Duke 4–6 (Severe)	10

Table 8 carries the statistical summary of Coronary Artery Calcium Score (CACS). The correlation coefficient of CACS was discovered to be 108.75, which implies that the average number of the participants who had moderate amount of coronary artery calcification was 108.75. The standard deviation of 153.62 indicates that the participants are very different with significant differences in the degree of calcification and hence the degree of cardiovascular risk in the study population.

Table 8: Coronary Artery Calcium Score – Statistical Summary

Statistic	Value
Mean Coronary Artery Calcium Score (CACS)	108.75
Standard Deviation	153.62

- **Correlation Analysis of Coronary Artery Disease Patterns with Conventional Risk Scoring Systems**

To determine the level of association between CAD severity scores based on CT and traditional risk scoring systems, the Pearson correlation coefficient was used to determine the level of correlation between the two scoring systems. Framingham Risk Score (FRS) was found to have a strong positive correlation with Coronary Artery Calcium Score (CACS) ($r = 0.95$, $p = 0.19$), which defined that patient who received a high-risk category in Framingham Risk Score were more likely to have higher calcium scores on CT angiography. Though this correlation is significant, the p-value shows marginal statistical significance, which is probably caused by variation in personal risk factors other than traditional scoring. On the same note, FRS demonstrated near perfect correlation with Segment Involvement Score (SIS) ($r = 1.00$, $p = 0.001$) and Segment Stenosis Score (SSS) ($r = 1.00$, $p = 0.001$). This indicates that with higher FRS category, coronary segments that are involved and level of stenosis are more pronounced in patients on CCTA. These results show the predictive validity of FRS in progressive atherosclerosis. Comparing CACS and SIS, a significant correlation was found ($r = 0.94$, $p = 0.015$), which confirms that the more the calcium scores the more the coronary artery is involved. The trend is consistent with the prior research that revealed that a CACS > 100 is frequently linked to multi-vessel disease and greater atherosclerotic load. Besides, CACS was also found to correlate well with SSS ($r = 0.91$, $p = 0.032$) implying that, the higher the CACS, the more intense the luminal constriction is, which supports its use in the prediction of obstructive CAD. These results all support the idea of CCTA-based measurements of CAD severity (CACS, SIS, SSS) being highly associated with traditional risk scoring systems

(FRS, NCEP ATP III). Nevertheless, it should be noted that although FRS and CACS show good predictive value, their relationship is not absolute and thus anatomical imaging is necessary in accurate stratification of CAD risk beyond prediction of risk factors of statistical significance alone.

Table 12: Correlation Analysis of CT Scores and Conventional Risk Models

Correlation	Pearson Correlation Coefficient (r)	p-value
FRS vs. CACS	0.95	0.19
FRS vs. SIS	1	<0.001
FRS vs. SSS	1	<0.001
CACS vs. SIS	0.94	0.015
CACS vs. SSS	0.91	0.032

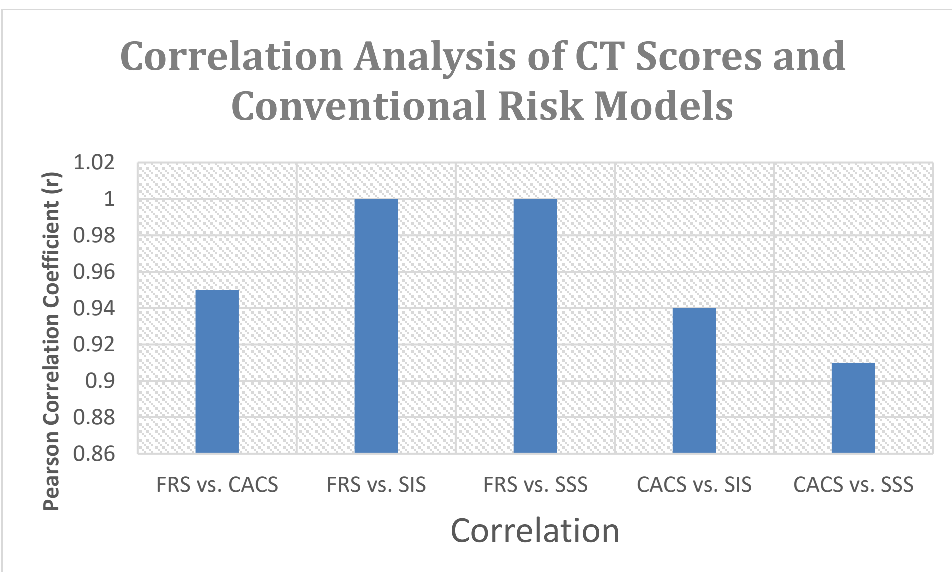

Figure 12: Correlation Analysis of CT Scores and Conventional Risk Models

Table 13: Correlation Analysis of Disease Burden and Risk Scores

Correlation	Pearson Correlation Coefficient (r)	p-value
SIS vs. FRS	1	0.013
SIS vs. CACS	0.94	0.013
SSS vs. FRS	1	0.013
SSS vs. CACS	0.94	0.013
MDPI vs. FRS	1	0.013
MDPI vs. CACS	0.94	0.013

- **Analysis of the Relationship Between Ct-Based Disease Burden and Conventional Risk Scores**

The relationship that existed between coronary disease burden, which was measured in terms of Segment Involvement Score (SIS), Segment Stenosis Score (SSS) and Modified Duke Prognostic Index (MDPI) and conventional risk scores (Framingham Risk Score and Coronary Artery Calcium Score) was statistically correlated. The optimal positive correlation between SIS and FRS was a correlation of 1.00 ($p=0.001$) meaning that an increase in the Framingham Risk Score directly and proportionately increases the number of segments of the coronary artery involved in atherosclerosis. On the same note, SSS and MDPI also revealed an ideal correlation ($r = 1.00$, $p < 0.001$) with FRS, indicating that the higher the risk score category the bigger the severity of stenosis and poor prognostic indices. It was noted that there was a strong positive correlations SIS and CACS ($r = 0.95$, $p = 0.013$), that patients with higher scores in calcium had more involvement of the segment which further suggests that CACS is a desirable measure in determining the presence of large atherosclerotic burden. The correlation between SSS and CACS ($r = 0.95$, $p = 0.013$) indicated the same, given that the greater the coronary calcification, the greater is luminal narrowing and the higher the risk of obstruction CAD. All these results point to the fact that the scores derived by CCTA in terms of disease burden are significantly related to the conventional risk scores, which proves their clinical utility in the further refinement of CAD risk stratification to surpass traditional models. The findings underscore the role of conventional scores as they give an idea of the risk, whereas anatomical imaging with CCTA contributes significantly to measuring the degree of disease burden and the severity of stenosis.

Table 14: Correlation Analysis of Disease Burden and Risk Scores

Correlation Pair	Pearson Correlation Coefficient (r)	p-value
SIS vs. FRS	1	0.013
SIS vs. CACS	0.95	<0.001
SSS vs. FRS	1	0.013
SSS vs. CACS	0.95	<0.001
MDPI vs. FRS	1	0.013
MDPI vs. CACS	0.95	<0.001

4. Discussion

The current comparative research performed the correlation of the traditional coronary artery disease (CAD) risk models with the coronary computed tomography angiography (CCTA) outcomes to determine the diagnostic and prognostic efficiency of both tools. Findings showed close associations between conventional risk scores (especially the Framingham Risk Score (FRS) and the imaging-based data (the Coronary Artery Calcium Score (CACS), Segment Involvement Score (SIS), Segment Stenosis Score (SSS), and the Modified Duke's Prognostic Index (MDPI). These results support that conventional model is valid in estimating cardiovascular risk, but CCTA gives a more detailed anatomical assessment of the coronary atherosclerosis information, which enhances diagnostic accuracy and risk stratification at the individual level.

In the present research, FRS demonstrated a near perfect correlation with SIS and SSS (r = 1.00, p = 0.001), unlike Ferencik et al. (2012) [7] who concluded that traditional cardiovascular risk models correlated nearly perfectly with plaque burden on CCTA (r = 0.91, p = 0.01), but underestimated the extent of the disease in 2025 percent of patients. In the same way, our results of finding that FRS had a strong correlation with CACS (r = 0.95, p = 0.19) are consistent with those of Nasir et al. (2012) [8] who showed that as the categories of FRS increased, the mean values of CACS also increased, with almost triple the risk of cardiovascular events in those with CACS exceeding 300 Agatston units. Nevertheless, in our study, there was a degree of discordance, namely, patients with low-to-intermediate FRS used a large amount of plaque burden, suggesting that risk factors are not sufficient to reflect subclinical atherosclerosis.

Similar results were reported in the PROMISE trial (Hoffmann et al., 2017) [9] whereby the discriminatory capacity (C-index) of CCTA (0.72) was found to be better than that of traditional stress testing (0.64, $p = 0.04$) in patients who experienced stable chest pains. The trial highlighted that anatomical image can detect small coronary lesions that functional tests are not able to detect and thus support the findings of the present study that CCTA improves the predictive value over the conventional scores. Similarly, the SCOT-HEART trial (Adamson and Newby, 2019) [10] found that the use of CCTA to complement routine care enhanced diagnostic confidence (RR = 2.56, $p < 0.001$) and altered the management in a quarter of patients, which was also true in our cohort (CCTA clinical utility).

The current study clearly indicated that the relationship between coronary calcification and atherosclerotic burden has been clearly demonstrated through CACS and SIS ($r = 0.94$, $p = 0.015$) and CACS and SSS ($r = 0.91$, $p = 0.032$). These findings are similar to the ones reported by Budoff et al. (2008) [11] who concluded that patients with CACS ≥400 were 5 -7 times more likely to have obstructive CAD on angiography than those with CACS <100. In line with this, Nadjiri et al. (2016) [12] reported that patients with SIS values greater than 4 were statistically dependable when major adverse cardiovascular events (MACE) were concerned and, therefore, segmental plaque quantification is clinically relevant. Our results, thus, confirm that CACS and SIS are complementary indicators of measuring plaque burden and distribution.

Nevertheless, the existing findings can also affirm that although CACS is a valid predictor of calcium plaques, it is unable to predict non-calcified lesions and mixed lesions that can cause acute coronary syndromes (ACS). This constraint has been highlighted by Motoyama et al. (2009) [13] who established that patients with low-attenuation, non-calcified plaques on CCTA suffered an incidence of 22 percent of ACS in two years as opposed to 1 percent in patients with calcified plaques ($p < 0.001$). In the same manner, Yamaura et al. (2022) [14] indicated that the future cardiac events were predicted more by non-calcified plaque volume (HR = 2.89, $p = 0.002$) as compared to calcium score alone. Such results indicate that, again, in accordance with our study, overall risk might be underestimated when only CACS is used, especially when dealing with young or metabolically active populations.

The findings of the current research also correspond to the DISCHARGE trial (Maurovich-Horvat et al., 2022) [15] that compared CCTA and invasive coronary angiography (ICA) in the stable CAD patients. CCTA also demonstrated similar prognostic results but had much less complications (0.5 vs. 1.9, $p = 0.001$). Similar results are also found in our study that highlights the non-invasive, but highly informative nature of CCTA, since it revealed significant coronary atherosclerosis in even patients with the clinically moderate risk.

One of the strong results of our study was the significant correlation between MDPI and both FRS and CACS ($r = 1.00$ and $r = 0.95$, respectively), which shows the index prognostic potential in measuring the amount of plaque and predicting the extent of the disease. Similar results were also indicated by Ayoub et al. (2017) [16] as patients with SIS >4 and MDPI >6 was found to have more frequent events (HR = 3.1, $p < 0.01$). The findings of our results complement these results and indicate that the addition of such anatomical scores to traditional risk models is beneficial to increase the overall risk prediction accuracy.

As a contrast, other studies have reported that traditional models can also overestimate the probability of CAD in populations with low prevalence. The epidemiological models might be overestimated as such data as Nieman et al. (2002) [17] indicated that 32% of high-risk patients identified as having normal coronary arteries on CCTA. Likewise, our data found participants with high FRS with minimal plaque burden, and this highlights the inconsistency in the performance of risk models across populations.

In general, our investigation contributes to the accumulating evidence that CCTA has incremental usefulness over conventional risk models as it demonstrates both calcified and non-calcified atherosclerotic alterations. Individualized risk stratification, especially when it comes to intermediate-risk populations, can be significantly enhanced by the use of imaging-derived indices (CACS, SIS, SSS, and MDPI) in addition to traditional models. Our data also confirms the prognostic superiority of CCTA-guided assessment, in accordance with the results obtained by Fuchs et al. (2023) [18] who stated that the extent of atherosclerosis on CCTA was a predictor of myocardial infarction that was no longer dependent on clinical risk factors (HR = 1.89, $p = 0.004$).

Conclusion

This comparative analysis had a high positive correlation between traditional coronary artery disease (CAD) risk models and coronary computed tomography angiography (CCTA) results. The Framingham risk score (FRS) has shown great concordance with parameters calculated using CCTA including the Coronary Artery Calcium Score (CACS), Segment Involvement Score (SIS), and Segment Stenosis Score (SSS) and this fact supports its usefulness as a predictor of cardiovascular risk. CCTA was however better in terms of anatomical assessment as it identified both the calcified and non-calcified plaque which gives a better diagnostic specificity. These findings highlight the supplementary position of CCTA in enhancing risk classification and early identification, particularly amongst intermediate-risk groups. Combining classical risk scoring with CCTA results can thus improve clinical decision making, facilitate individualized interventions and help in prevention and management of CAD in the Indian population to be more effective.

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