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Evaluating CT Coronary Angiography as a Screening Tool for Coronary Artery Disease in India: A Comprehensive Review

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Abstract

Coronary Artery Disease (CAD) is a leading cause of mortality worldwide, notably affecting younger populations in India. This study proposes Computed Tomography Coronary Angiography (CTCA) as a preventive measure, advocating for screening every 5 years to detect CAD early, irrespective of risk factors. CTCA offers detailed imaging and non-invasiveness, aiding in lesion identification for prompt intervention. The Coronary Artery Disease - Reporting and Data System (CAD-RADS) provides a standardized approach for interpreting CTCA findings and guiding patient management, categorizing patients based on CAD severity. The Framingham Risk Score assists in stratifying individuals by Coronary Heart Disease (CHD) risk, with a focus on screening asymptomatic individuals with intermediate to high risks. This strategy aims to optimize outcomes and reduce CAD-related mortality. Similar to cancer screening, early CAD detection through proactive CTCA could significantly mitigate CAD complications. By identifying lesions early and initiating timely interventions, this approach aims to improve patient outcomes and decrease CAD burden. This study highlights the importance of proactive CAD screening, supported by CAD-RADS and risk assessment tools. Such an approach has the potential to reduce global CAD morbidity and mortality rates significantly. In conclusion, early CAD detection through CTCA screening, in conjunction with CAD-RADS guidelines and risk assessments, offers a proactive strategy to mitigate disease progression and improve patient outcomes in the fight against Coronary Artery Disease.

Keywords: Syndromes; Coronary; Disease; Symptoms; Paradigms; Paradigms; Angiography; Treatment; Cancer; Mammography; Mammography

Abbreviations

CAD: Coronary Artery Disease; CTCA: Computed Tomography Coronary Angiography; CAD-RADS: Coronary Artery Disease-Reporting and Data System; CHD: Coronary Heart Disease; CVD: cardiovascular Disease; CTCA: Computed Tomography Coronary Angiography; WHO: World Health Organization.

Introduction

Coronary Artery Disease (CAD) stands as a formidable global health challenge, encompassing a range of syndromes rooted in myocardial ischemia. Despite significant therapeutic strides, CAD continues to hold its position as the foremost cause of mortality, claiming 7 million lives annually

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worldwide. Of particular concern is its impact on India, where a striking one-fifth of global CAD-related deaths occur, and disproportionately affecting younger populations. The burden is underscored by the World Health Organization's report of an alarming age-standardized Cardiovascular Disease (CVD) death rate of 272 per 1,00,000 population in India, surpassing the global average. In response to this pressing health crisis, this study advocates for the integration of Computed Tomography Coronary Angiography (CTCA) as a pivotal screening tool. The proposed approach is underpinned by the Coronary Artery Disease - Reporting and Data System (CAD-RADS), a comprehensive framework endorsed by leading cardiovascular imaging societies. CAD-RADS offers a standardized methodology for interpreting CTCA findings, thereby guiding tailored and effective management strategies. By delving into the nuances of CAD-RADS categories, from absence to severe coronary artery disease, this study elucidates the significance of maximal stenosis thresholds and corresponding management recommendations. Through this systematic approach, clinicians are empowered to make informed decisions, thereby enhancing patient care outcomes. This article aims to shed light on the pivotal role of CTCA in early CAD detection and its potential to transform preventive healthcare paradigms. The integration of CAD-RADS as a clinical decision support system promises to streamline patient management, optimize treatment efficacy, and ultimately mitigate the formidable impact of Coronary Artery Disease.

Discussion

Coronary artery disease (CAD) is a comprehensive term encompassing various closely linked syndromes resulting from myocardial ischemia. Despite significant advancements in therapy over the past twenty-five years, CAD in its diverse forms continues to be the leading cause of mortality in the United States, contributing to 7 million deaths worldwide annually. According to the World Health Organization (WHO), India is responsible for a fifth of these global deaths, particularly impacting the younger population. The findings of the Global Burden of Disease study reveal an age-standardized Cardiovascular Disease (CVD) related death rate of 272 per 100,000 populations in India, significantly surpassing the global average of 235. CVDs tend to affect Indians a decade earlier than their Western counterparts [1]. Indians are known to have the highest CAD rates and the conventional risk factors fail to explain this increased risk, and also the majority of deaths happen at home without knowing the exact cause of death. The prevalence of CAD in Indians living in India is 21.4% for diabetics and 11% for Non-diabetics. The prevalence of CAD in rural part of country is nearly half than in urban population [2].

Actively seeking diseases in individuals who appear to be healthy is a fundamental component of preventive measures. This concept is manifested through screening, which is characterized as "the exploration for unrecognized disease or defects through swiftly administered tests, examinations, or other procedures in seemingly healthy individuals." Lead time refers to the benefit derived from screening, signifying the duration between early detection diagnosis and diagnosis through alternative methods. In Figure 1, A is the usual outcome of the disease, B is the outcome expected when the disease is detected at the earliest possible moment. The benefit of the screening test is therefore B-A [3].

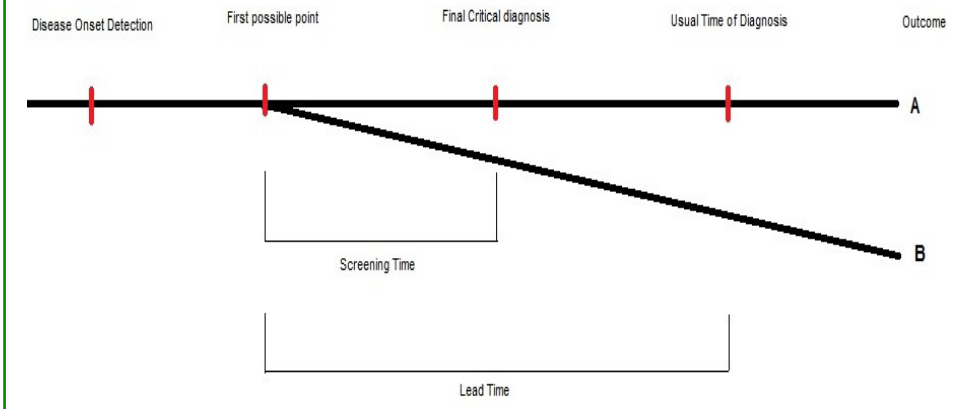

Figure 1: Advantage of Screening Test in outcomes.

Computed tomography coronary angiography (CTCA) has been shown to be an alternative imaging technique for the evaluation of CAD. CTCA excludes obstructive CAD with high accuracy. CTCA may be used to detect or exclude high-risk

CAD. CTCA being a non-invasive modality is an appealing investigation to the population with no requirement of hospital admission, and readily available reporting [4]. CTCA is typically conducted using a conventional ECG-synchronized low-pitch helical CT protocol. This approach helps to minimize the effective radiation dose. Subsequently, datasets are reconstructed retrospectively, considering the low-pitch and step-and-shoot sequential CT protocols. These reconstructions are done at specific phases of the cardiac cycle: the systolic phase (31-47%) and diastolic phase (60-76%) of the RR interval are utilized for individuals with high heart rates (≥80 beats/min) and low heart rates (≤65 beats/min), respectively. For those with medium heart rates (66-79 beats/min), both systolic and diastolic phases (30-77%) of the RR interval are employed. This process ensures the creation of motion-free images for accurate assessment [5]. as shown in figure 2.

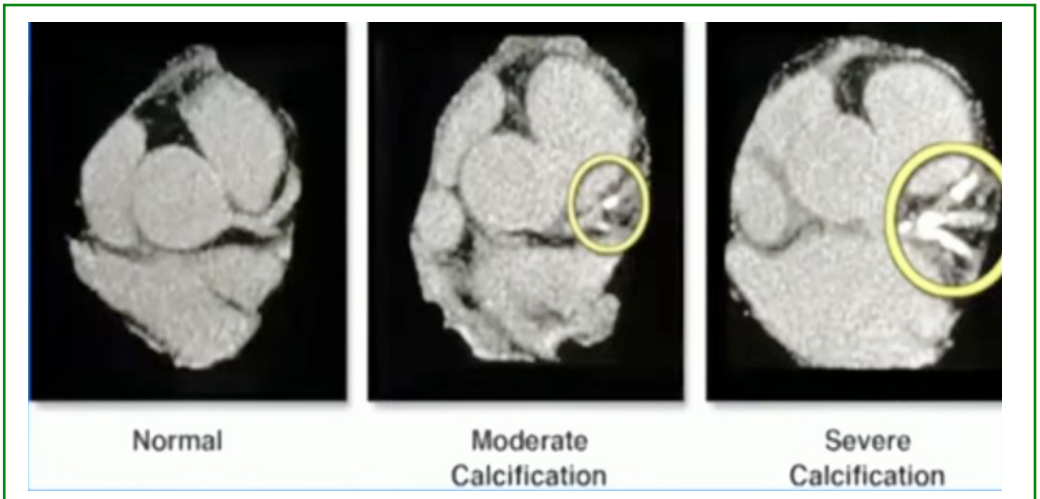

Figure 2: Normal, moderate calcification, and severe calcification as shown in CTCA.

A meta-analysis revealed that the presence of coronary calcium had a sensitivity and specificity of 98% and 40%, respectively, in detecting significant stenosis. [6] The Coronary artery Calcium (CAC) score is used as a gatekeeper for CTA when the CAC score is very high. A normal calcium test score is zero, which indicates no calcification in the heart's arteries. A higher score indicates a higher risk of heart disease [7]:

- Score of zero: No calcium is seen in the heart, which suggests a low chance of developing a heart attack in the future.
- Score of 100 to 300: Moderate plaque deposits, associated with a relatively high risk of a heart attack or other heart disease over the next 3 to 5 years.
- Score greater than 300: A sign of more extensive disease and a higher heart attack risk.
- The Framingham Risk Score is a tool used to calculate the 10-year risk percentage of Coronary Heart Disease (CHD). It categorizes individuals into different risk groups: low risk, with a 10% or lower CHD risk at 10 years; intermediate risk, with a 10-20% risk; and high risk, with a 20% or higher risk.

This score takes into account several factors such as age, sex, LDL cholesterol, HDL cholesterol, blood pressure (including whether hypertension is treated or not), diabetes status, and smoking habits. It provides an estimate of an individual's likelihood of developing CHD over the next decade [8,9].

The Coronary Artery Disease - Reporting and Data System (CAD-RADS) is a standardized approach developed to report and communicate findings from coronary CT angiography. This system serves as a crucial clinical decision support tool, aiding healthcare providers in determining the appropriate next steps for patient management. Created through collaboration among the Society for Cardiovascular Computed Tomography, the American College of Radiology and the North American Society for Cardiovascular Imaging, CAD-RADS has also received endorsement from the American College of Cardiology. Its structured framework enhances the consistency and clarity of CT angiography results, facilitating more informed and effective patient care decisions, as highlighted in Table 1 [10].

CAD-RADS	Interpretation	Stenosis	Management Recommendation
CAD-RADS 0	Absence of CAD	0% - no coronary luminal stenosis and no plaque	No further cardiac instigations. Consider non-atherosclerotic cause of chest pain.
CAD-RADS I	Minimal non-obstructive CAD	1-24 % - minimal stenosis or plaque with no stenosis	No further cardiac instigations. Consider non-atherosclerotic cause of chest pain.
CAD-RADS II	Mild non-obstructive CAD	25-49% - mild stenosis	No further cardiac investigation. Consider non-atherosclerotic causes of chest pain. Preventive therapy and risk factor modification.
CAD-RADS III	Moderate Stenosis	50-69% - Moderate Stenosis	Consider functional assessment. Aggressive preventive therapy and risk factor modification. Consider other treatments including anti-anginal therapy as per guidelines. I+: Consider invasive coronary angiography, in particular in the setting of persistent symptoms despite optimal medical therapy.
CAD-RADS IV	Severe Stenosis	IV a – 70-99 % severe coronary stenosis IV b – left mail > 50% stenosis or three-vessel obstructive disease with ≥ 70% stenosis	IV a – Consider invasive coronary angiography or functional assessment. IV b-Invasive coronary angiography.
CAD-RADS V	Total or subtotal coronary occlusion	100 % coronary occlusion	Consider invasive coronary angiography, functional and/or viability assessment. Consider other treatments including anti-anginal therapy and revascularisation therapy as per guidelines.
CAD-RADS N	Exclusion of obstructive CAD not possible	Non-diagnostic	Additional and/or alternative assessment as necessary.

Table 1: Table summarizing the interpretations, maximal stenosis ranges, and management recommendations for each CAD-RADS category.

One of the most impactful applications of screening tests lies in the field of cancer diagnosis and treatment, particularly the use of screening mammography. The benefits and risks of mammography screening differ for women in their 40s compared to older women, owing to their longer life expectancy, less comorbidity, and the potential for more aggressive forms of breast cancer. The primary advantages include reducing mortality rates, saving years of life, and minimizing treatment-related morbidity. Currently, it is recommended that asymptomatic females above the age of 40 undergo screening mammography annually. Similarly, screening colonoscopy is advised every 10 years for individuals above the age of 50 [11, 12]. We propose that in light of the significant mortality and morbidity linked to CAD, screening with CTCA should be conducted for every individual, regardless of their risk factors, at intervals of every 5 years, even in the absence of symptoms. Subsequent management can then follow the recommendations outlined by the CAD-RADS guidelines. Detecting lesions at an earlier stage allows for the initiation of treatment sooner, thereby impeding disease progression and potentially reducing associated mortality rates. The demographic that stands to benefit the most from screening coronary angiography would be asymptomatic individuals with intermediate to high risks, as determined by the Framingham risk score. This approach ensures timely intervention and management for those at elevated risk, thus optimizing outcomes and potentially decreasing the burden of CAD-related complications.

Conclusion

Given the significant disease burden of CAD, it is imperative to identify screening tests that can detect the condition in its early stages. Early detection enables timely intervention, potentially slowing disease progression and allowing for revascularization procedures before symptoms manifest. Among non-invasive tests, CTCA stands out for its exceptional ability to provide detailed anatomical information, making it an ideal candidate for screening asymptomatic individuals for CAD.

Declaration

In accordance with the principles of the Helsinki Declaration, this research respects the rights, dignity, and well-being of human participants, ensuring informed consent, confidentiality, and the ability to withdraw without consequence. No animals were included in the study.

Conflict of Interest

The author declares no conflict of interest.

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