

**Original Research Article****Correlation between CT Coronary Angiogram and Invasive Coronary Angiogram in Patients with Suspected Angina Pectoris**

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Received: 14-09-2024 / Revised: 30-09-2024 / Accepted: 16-11-2024

**ABSTRACT****Background**

Coronary artery disease (CAD) is major non communicable disease leading to heavy burden of morbidity and mortality. During the last decade till now, coronary computed tomography (CCTA) has emerged and proved its excellent utility in the assessment of CAD. In addition to being a non-invasive tool, it has shown high negative predictive value in ruling out obstructive CAD. Thus we aimed to investigate the correlation between CT coronary angiogram and invasive coronary angiogram in patients of suspected angina pectoris presenting with chest pain.

**Methods**

The present Non randomized prospective study was conducted in out patient and emergency Department of Cardiology, KIMS, Hubballi from March 1 2023 to February 28 2024 on patients presenting with features of typical anginal type of chest pain. Total 32 patients were included the study as per inclusion and exclusion criteria. Demographic profile, blood investigations, CT Coronary angiogram and Invasive coronary angiogram were done for all the patients and results of CT CAG and Invasive coronary angiogram were compared.

**Results**

Lesion estimated on CT CAG does not correlate with those in Invasive coronary angiogram. Zero CT Calcium score cannot conclusively help ruling out CAD. For detecting anomalous coronaries CT CAG is equally effective as Invasive coronary angiogram. Non – dominant RCA was falsely interpreted as stenosed (Overestimation).

**Conclusion**

Invasive Coronary angiogram is Gold standard for ruling out Coronary artery disease in patients with suspected angina pectoris with normal ECG, echocardiography and biomarkers

**Keywords:** Angina Pectoris, CT Coronary Angiogram, Invasive Coronary Angiogram, Coronary Artery Disease.

## INTRODUCTION

Coronary artery disease (CAD) is major non communicable disease leading to heavy burden of morbidity and mortality. Presentation of coronary artery disease can be varibale ranging from Sudden cardiac death, acute coronary syndrome to atypical symptoms.

ACS includes acute myocardial infarction (AMI), encompassing both ST-elevation myocardial infarction (STEMI) and non-ST segment myocardial infarction (NSTEMI), and unstable angina pectoris (UA). The presence of an STEMI is usually identified on initial electrocardiogram (ECG), whereas UA and NSTEMI require further clinical evaluations. UA is defined as chest pain due to ischemia without the presence of myocardial necrosis, whereas NSTEMI requires the presence of myocardial necrosis, manifested by troponin elevation. It should be noted that UA and NSTEMI are therefore indistinguishable until serial troponin or other biomarkers of myocardial injury are assessed.

A traditional diagnostic work-up of acute chest pain includes an initial clinical assessment and determining whether the patient is suffering from ACS; determination is done by patient's history, physical examination, 12-lead ECG, and laboratory findings, such as cardiac biomarkers. Patients with high-risk findings can be readily diagnosed and referred for invasive diagnosis and treatment. Low-risk patients can be readily discharged for outpatient follow-up. However, a large proportion of patients remain in the ED or in a dedicated chest pain unit until ACS can be reliably ruled out. These patients undergo serial cardiac biomarkers and ECG testing during the next 24 hours, frequently followed by a stress test for risk stratification, if subsequent ECG and biomarkers tests are inconclusive. Although the number of missed ACS events can be reduced with this common strategy, it leads to increased test burden, length of hospitalization, and prolonged stay in the chest pain unit. Despite the conservative triage practice, 2–3% of all patients suffering from ACS within 72 hours of ED presentation are erroneously discharged, contributing to the fact that missed ACS is the number one cause for ED malpractice costs in the United States.

Though invasive coronary angiogram is considered Gold standard and safe for the diagnosis of CAD, risk adverse effects of an invasive procedure are inevitable and more than 50% of patients currently referred to coronary angiography show normal or nonobstructive cad.<sup>[1]</sup> Furthermore, invasive coronary angiography usually requires a short hospital stay and causes patient discomfort.

Inorder to exclude the risk of subjecting a patient of a suspected stable angina pectoris for the diagnosis of CAD to a invasive coronary angiogram, there is a need for better non-invasive test, especially where ECG, echocardiography and stress test are non diagnostic.

During the last decade till now, coronary computed tomography (CCTA) has emerged and proved its excellent utility in the assessment of CAD.<sup>[2]</sup>

In addition to being a non-invasive tool, it has shown high negative predictive value in ruling out obstructive CAD.<sup>[3]</sup>

Thus we aimed to investigate the correlation between CT coronary angiogram and invasive coronary angiogram in patients of suspected angina pectoris presenting with chest pain.

## OBJECTIVES

1. To study the correlation between CT coronary angiogram and invasive coronary angiogram in patients of suspected stable angina pectoris

2. To study Negative predictive value of CT coronary angiogram to rule of CAD in patients with stable angina pectoris
3. To compare the severity of lesions in CT coronary angiogram with conventional coronary angiography

## **MATERIALS & METHODS**

The present Non randomized prospective study was conducted in out patient and emergency Department of Cardiology, KIMS, Hubballi from March 1 2023 to February 28 2024 on patients presenting with features of typical anginal type of chest pain.

Patients were selected according to inclusion and exclusion criteria after taking written consent.

Patients were asked thorough history, clinical examination was performed. ECG, echocardiography and biomarkers were done.

Oral administration of 50 mg of metoprolol (50mg) was given in patients who had heart rates between 60-70 beats/minute 60 minutes prior to the scheduled CT scan and 100 mg metoprolol in case of >70 beats/minute. Computed topographic angiography was performed using a 128-slice MDCT scanner. A bolus of 1.2 ml/kg ml of contrast agent.

Within 15 days patients were subjected to Conventional invasive angiogram. Results were compared.

### **Inclusion Criteria**

1. Age above 18 years (male and female patients)
2. Typical anginal type of chest pain

Angina pectoris is perceived as a retrosternal chest discomfort that builds gradually in intensity (over several minutes), is usually precipitated by stress (physical or emotional) or occurring at rest (as in the case of an ACS) with characteristic radiation (eg, left arm, neck, jaw) and its associated symptoms (eg, dyspnea, nausea, lightheadedness). When actively treated or spontaneously resolving, it dissipates over a few minutes. Relief with nitroglycerin is not necessarily diagnostic of myocardial ischemia and should not be used as a diagnostic criterion, especially because other entities demonstrate comparable response (eg, esophageal spasm). Associated symptoms such as shortness of breath, nausea or vomiting, lightheadedness, confusion, presyncope or syncope, or vague abdominal symptoms are more frequent among patients with diabetes, women, and the elderly. A detailed assessment of cardiovascular risk factors, review of systems, past medical history, and family and social history should complement the assessment of presenting symptoms.<sup>[4]</sup>

### **Exclusion Criteria**

1. Confirmed acute coronary syndromes (according to Eelectrocardiophy, echocardiography and positive biomarkers)
2. Hemodynamically unstable patients
3. Patients who have undergone PTCA/CABG
4. Serum creatinine of more than 1.5mg/dl
5. Patients not giving consent

## RESULTS

| Age Groups (years)          | Number | Percentage |
|-----------------------------|--------|------------|
| 24-40                       | 5      | 15.6       |
| 41-50                       | 14     | 43.8       |
| >50                         | 13     | 40.6       |
| Total                       | 32     | 100.0      |
| <b>Age distribution</b>     |        |            |
| Gender                      | Number | Percentage |
| Male                        | 20     | 62.5       |
| Female                      | 12     | 37.5       |
| Total                       | 32     | 100.0      |
| <b>Gender Distribution</b>  |        |            |
| Co-morbid conditions        | Number | Percentage |
| <b>Diabetes mellitus</b>    |        |            |
| Present                     | 17     | 53.1       |
| Absent                      | 15     | 46.9       |
| <b>Hypertension</b>         |        |            |
| Present                     | 7      | 21.9       |
| Absent                      | 25     | 78.1       |
| <b>Tobacco use</b>          |        |            |
| Present                     | 10     | 31.3       |
| Absent                      | 22     | 68.8       |
| <b>Smoking</b>              |        |            |
| Present                     | 4      | 12.5       |
| Absent                      | 28     | 87.5       |
| <b>Alcohol use</b>          |        |            |
| Present                     | 4      | 12.5       |
| Absent                      | 28     | 87.5       |
| <b>Co-morbid conditions</b> |        |            |

*Table 1: Demographic distribution*

The study included participants across three age groups: 24-40 years, 41-50 years, and over 50 years. The 24-40 age group comprised 5 individuals, representing 15.6% of the total sample. The 41-50 age group was the largest, with 14 participants, accounting for 43.8% of the sample. The over 50 age group included 13 individuals, making up 40.6%. The sample consisted of 32 participants, with a gender distribution of 20 males (62.5%) and 12 females (37.5%). This distribution reflects the total sample size, with males comprising the majority of the participants. The sample included participants with various co-morbid conditions. Diabetes mellitus was present in 17 individuals (53.1%) and absent in 15 individuals (46.9%). Hypertension was reported by 7 participants (21.9%), while 25 participants (78.1%) did not have hypertension. Tobacco use was present in 10 participants (31.3%) and absent in 22 participants (68.8%). Smoking was reported by 4 participants (12.5%), with 28 participants (87.5%) not smoking. Similarly, alcohol use was present in 4 participants (12.5%) and absent in 28 participants (87.5%).

|                                                               | Invasive Coronary Angiogram |       |      |       |       |
|---------------------------------------------------------------|-----------------------------|-------|------|-------|-------|
| CT coronary angiography                                       | Right                       |       | Left |       | Total |
|                                                               | n                           | %     | n    | %     |       |
| Right                                                         | 30                          | 100.0 | 1    | 50.0  | 31    |
| Left                                                          | 0                           | -     | 1    | 50.0  | 1     |
| Total                                                         | 30                          | 100.0 | 2    | 100.0 | 32    |
| Table 2: Comparison of dominance by CT and invasive angiogram |                             |       |      |       |       |

Out of 32 participants, invasive angiogram shows 30 were right dominance and 1 were left dominance. And CT coronary angiography also showed that sensitivity of 100% for identifying dominance when compared to invasive angiogram.

| CT Coronary Angiography                                           | Invasive Coronary Angiogram |       |               |       |                   |       |                 |       | Total |
|-------------------------------------------------------------------|-----------------------------|-------|---------------|-------|-------------------|-------|-----------------|-------|-------|
|                                                                   | Normal                      |       | Mild Stenosis |       | Moderate Stenosis |       | Severe Stenosis |       |       |
|                                                                   | n                           | %     | n             | %     | n                 | %     | n               | %     |       |
| Normal                                                            | 24                          | 96.0  | 0             | 0.0   | 0                 | 0.0   | 1               | 25.0  | 25    |
| Minimal stenosis                                                  | 0                           | 0.0   | 1             | 50.0  | 0                 | 0.0   | 0               | 0.0   | 1     |
| Mild stenosis                                                     | 1                           | 4.0   | 0             | 0.0   | 1                 | 100.0 | 0               | 0.0   | 2     |
| Moderate stenosis                                                 | 0                           | 0.0   | 1             | 50.0  | 0                 | 0.0   | 3               | 75.0  | 4     |
| Total                                                             | 25                          | 100.0 | 2             | 100.0 | 1                 | 100.0 | 4               | 100.0 | 32    |
| Table 3: Comparison of LAD occlusion by CT and invasive angiogram |                             |       |               |       |                   |       |                 |       |       |

Invasive angiogram showed that 2 case as mild stenosis, 1 as moderate stenosis and 4 as severe stenosis out of 32 cases. Out of 2 cases identified as mild, CT identified one (50.0%) as mild and (50.0%) as moderate stenosis. Out of 4 cases identified as severe by invasive angiogram, 3 (75.0%) were identified as moderate stenosis and 1 (25%) as identified as normal. One patient in which LAD was shown as normal in CT CAG but had severe stenosis on Invasive angiogram

For the identification of LAD occlusion, CT coronary angiography has a sensitivity of 85.7%, specificity of 96%, PPV of 85.7% and NPV of 96%. The diagnostic accuracy was 93.8%.

| CT Coronary Angiography                                           | Invasive Coronary Angiogram |       |                 |       | Total |
|-------------------------------------------------------------------|-----------------------------|-------|-----------------|-------|-------|
|                                                                   | Normal                      |       | Severe Stenosis |       |       |
|                                                                   | n                           | %     | n               | %     |       |
| Normal                                                            | 29                          | 100.0 | 1               | 33.3  | 30    |
| Moderate stenosis                                                 | 0                           | 0.0   | 1               | 33.3  | 1     |
| Severe stenosis                                                   | 0                           | 0.0   | 1               | 33.3  | 1     |
| Total                                                             | 29                          | 100.0 | 3               | 100.0 | 32    |
| Table 4: Comparison of LCX occlusion by CT and invasive angiogram |                             |       |                 |       |       |

Invasive angiogram showed that 29 cases as normal and 3 cases were severe stenosis out of 32 cases. Of the 3 severe stenosis cases 1 (33.3%) were identifies as sev

For the identification of LCX occlusion, CT coronary angiography has a sensitivity of 66.7%, specificity of 100%, PPV of 100% and NPV of 96.7% when compared to invasive angiogram. The diagnostic accuracy was 96.9%.

| CT Coronary Angiography                                           | Invasive Angiogram |       |                 |       | Total |
|-------------------------------------------------------------------|--------------------|-------|-----------------|-------|-------|
|                                                                   | Normal             |       | Severe Stenosis |       |       |
|                                                                   | n                  | %     | n               | %     |       |
| Normal                                                            | 25                 | 89.3  | 0               | 0.0   | 25    |
| Moderate stenosis                                                 | 1                  | 3.6   | 0               | 0.0   | 1     |
| Severe stenosis                                                   | 0                  | 0.0   | 3               | 75.0  | 3     |
| Occluded                                                          | 2                  | 7.1   | 1               | 25.0  | 3     |
| Total                                                             | 28                 | 100.0 | 4               | 100.0 | 32    |
| Table 5: Comparison of RCA occlusion by CT and invasive angiogram |                    |       |                 |       |       |

Invasive angiogram identified 4 cases as severe stenosis in RCA occlusion out of 32. Of this 4 severe stenosis cases 3 (75%) were correctly identified by CT angiography and 1 (25%) were identified as occluded. Out of 28 normal cases, 25 (89.3%) were correctly identified as normal by CT angiography. For the identification of RCA occlusion, CT coronary angiography has a sensitivity of 100%, specificity of 89.3%, PPV of 57.1% and NPV of 100% when compared to invasive angiogram. The diagnostic accuracy was 90.6%. Two patients CT coronary angiogram showed significant >75% stenosis but on invasive angiogram it was found to be normal and non-dominant. So non-dominant Right coronary artery was falsely interpreted as stenosed on CT coronary angiogram.

| CT Coronary Angiography                                            | Invasive Angiogram |       |              |       | Total |
|--------------------------------------------------------------------|--------------------|-------|--------------|-------|-------|
|                                                                    | Normal             |       | 95% Stenosis |       |       |
|                                                                    | n                  | %     | n            | %     |       |
| Normal                                                             | 30                 | 96.8  | 1            | 100.0 | 31    |
| Focal wall calcification                                           | 1                  | 3.2   | 0            | -     | 1     |
| Total                                                              | 31                 | 100.0 | 1            | 100.0 | 32    |
| Table 6: Comparison of LMCA occlusion by CT and invasive anqioqram |                    |       |              |       |       |

One case was identified as 95% stenosis by invasive angiogram and CT identify it as focal wall calcification. Out of 31 cases, 30 were correctly identifies as normal by CT angiography.

| Parameter(LAD)            | Point Estimate | 95 % Confidence Limit |
|---------------------------|----------------|-----------------------|
| <b>LAD</b>                |                |                       |
| Sensitivity               | 85.7           | 48.7-97.4             |
| Specificity               | 96.0           | 80.5-99.3             |
| Positive predictive value | 85.7           | 48.7-97.4             |
| Negative predictive value | 96.0           | 80.5-99.3             |
| Diagnostic accuracy       | 93.8           | 79.9-98.3             |
| <b>LCX</b>                |                |                       |
| Parameter(LCX)            | Point estimate | 95 % Confidence limit |
| Sensitivity               | 66.7           | 20.8-93.9             |

|                                                                                               |                       |                              |
|-----------------------------------------------------------------------------------------------|-----------------------|------------------------------|
| Specificity                                                                                   | 100.0                 | 88.3-100.0                   |
| Positive predictive value                                                                     | 100.0                 | 34.2-100.0                   |
| Negative predictive value                                                                     | 96.7                  | 83.3-99.4                    |
| Diagnostic accuracy                                                                           | 96.9                  | 84.3-99.5                    |
| <b>RCA</b>                                                                                    |                       |                              |
| <b>Parameter(RCA)</b>                                                                         | <b>Point estimate</b> | <b>95 % Confidence limit</b> |
| Sensitivity                                                                                   | 100.0                 | 51.1-100.0                   |
| Specificity                                                                                   | 89.3                  | 72.8-96.3                    |
| Positive predictive value                                                                     | 57.1                  | 25.1-84.2                    |
| Negative predictive value                                                                     | 100.0                 | 86.7-100.0                   |
| Diagnostic accuracy                                                                           | 90.6                  | 75.8-96.8                    |
| <b>Table 7: Diagnostic Accuracy Comparison between CT CAG and Invasive CORONARY Angiogram</b> |                       |                              |

Out of 4 cases identified as anomalous origin by invasive angiogram, 2 (50%) were correctly identified by CT. For the identification of normal cases it has a sensitivity of 96.4%.

For the LAD, the mean and SD for normal cases are 54.9 and 173.2, respectively, while for abnormal cases, they are 230.0 and 478.7, with a P value of 0.37, indicating no statistically significant difference. For the LCX, the mean and SD for normal cases are 55.3 and 158.9, respectively, while for abnormal cases, they are 661.5 and 917.1, with a P value of 0.52, also indicating no statistically significant difference. For the RCA, the mean and SD for normal cases are 65.7 and 172.7, respectively, while for abnormal cases, they are 191.5 and 493.3, with a P value of 0.53, again indicating no statistically significant difference. For the LMCA, the mean and SD for normal cases are 95.4 and 278.7, respectively, while there is only one abnormal case with a mean of 0 and no SD, and no P value provided. Overall, these results indicate that there are no statistically significant differences in the means of the examined coronary arteries between normal and abnormal cases as per the CT coronary angiography.

For the identification of LAD occlusion, CT coronary angiography has a sensitivity of 85.7%, specificity of 96%, PPV of 85.7% and NPV of 96%. The diagnostic accuracy was 93.8%.

For the identification of LCX occlusion, CT coronary angiography has a sensitivity of 66.7%, specificity of 100%, PPV of 100% and NPV of 96.7% when compared to invasive angiogram. The diagnostic accuracy was 96.9%.

For the identification of RCA occlusion, CT coronary angiography has a sensitivity of 100%, specificity of 89.3%, PPV of 57.1% and NPV of 100% when compared to invasive angiogram. The diagnostic accuracy was 90.6%.

Out of 4 cases identified as anomalous origin by invasive angiogram, 2 (50%) were correctly identified by CT. For the identification of normal cases it has a sensitivity of 96.4%.

For the LAD, the mean and SD for normal cases are 54.9 and 173.2, respectively, while for abnormal cases, they are 230.0 and 478.7, with a P value of 0.37, indicating no statistically significant difference. For the LCX, the mean and SD for normal cases are 55.3 and 158.9, respectively, while for abnormal cases, they are 661.5 and 917.1, with a P value of 0.52, also indicating no statistically significant difference. For the RCA, the mean and SD for normal cases are 65.7 and 172.7, respectively, while for abnormal cases, they are 191.5 and 493.3, with a P value of 0.53, again indicating no statistically significant difference. For the LMCA, the mean and SD for normal cases are 95.4 and 278.7, respectively, while there is only one abnormal case with a mean of 0 and no SD, and no P value provided. Overall, these results indicate that there

are no statistically significant differences in the means of the examined coronary arteries between normal and abnormal cases as per the CT coronary angiography.

## DISCUSSION

According to Antonio Moscariello et al<sup>[5]</sup> in patients with high likelihood of CAD, the performance of coronary CT angiography in the differentiation of patients without and patients with a need for revascularization and the selection of a revascularization strategy was similar to that of cardiac catheterization. Of the 185 patients, 113 (61%) did not undergo revascularization and 42 (23%) were free of CAD. In 178 patients (96%), the same therapeutic strategy (conservative treatment vs revascularization) was chosen on the basis of coronary CT angiography and catheterization. All patients in need of revascularization were identified with coronary CT angiography. In our study sensitivity for identifying CAD in LAD, LCX and RCA was 86%, 67% and 100%. To note non-dominant RCA was falsely interpreted as occluded, thus keep the specificity of test for RCA to 90%

According to Joon-Hyung Doh et al<sup>[6]</sup> anatomical criteria for the diagnosis of ischaemia-producing coronary stenosis differ by non-invasive and invasive methods. Compared with invasive methods, ccta presents overestimation in assessing lesion severity and lower diagnostic performance in assessing ischaemia. 181 coronary lesions with intermediate severity were studied in this study. In our study no particular pattern was identified in terms of estimation i.e., over/ under.

According to Steffen Huber et al<sup>[7]</sup> Sixteen-slice MSCT coronary angiography cannot routinely provide diagnostically useful images in patients with acute chest pain in the emergency department. Ninety-eight patients in the emergency department (41 men, 57 women; mean age SD, 48.1 11.9 y) with acute chest pain underwent MSCT coronary angiography. Coronary calcium (Agatston) scoring was performed, followed by contrast-enhanced MSCT. Images were evaluated for mean image quality (MIQ) and for degree of stenosis. These data were correlated with body mass index (BMI; in kg/m<sup>2</sup>), heart rate, beat-to-beat variation, and calcium score to assess their influence on image quality. In our study CT Calcium there was no correlation between CT Calcium score and accuracy for identifying CAD. One patient with CT Calcium score of zero was found to have Significant LAD disease.

According to M H Maurer et al<sup>[8]</sup> CCTA is accepted by the referring physicians as an alternative imaging procedure for the exclusion of CHD and received a predominantly positive assessment from both the referring physicians and the patients. 53 questionnaires (30 %) were assessable, corresponding to more than 72 % of the patients referred. Of the referring physicians who responded, 94 % saw a concrete advantage of CCTA in the treatment of patients, whereby 87 % were 'satisfied' or 'very satisfied' with the reporting. For excluding coronary heart disease (CHD) where there was a low pre-test probability of disease, the physicians considered CCTA to be superior to conventional coronary diagnosis (4.2 on a scale of 1 – 5) and vice versa for acute coronary syndrome (1.6 of 5).

According to M Mannan et al<sup>[9]</sup> Contrast-enhanced 64-slice MDCT allows the identification of coronary stenosis with excellent accuracy. Measurements of stenosis derived by MDCT correlated well with conventional angiogram. A major limitation is the insufficient ability of CT to exactly quantify the degree of stenosis. Fifty patients scheduled for conventional coronary angiography at the department of Radiology and Imaging, United Hospital, Dhaka were

enrolled between July 2007 and June 2008. All patients underwent both conventional and MDCT angiography within mean 10.70 days.

Correlating with our study there was no correlation between estimation of lesions in CT Cag and invasive CAG.

## LIMITATIONS

Small sample size

## CONCLUSION

1. Invasive Coronary angiogram is Gold standard for ruling out Coronary artery disease in patients with suspected angina pectoris with normal ECG, echocardiography and biomarkers.
2. Non – dominant RCA was falsely interpreted as stenosed (Overestimation)
3. Zero CT Calcium score cannot conclusively help ruling out CAD
4. Lesion estimated on CT CAG doesnot correlate with those in Invasive coronary angiogram
5. For detecting anomolous coronaries CT CAG is equally effective as Invasive cortonary angiogram.

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