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ORIGINAL ARTICLE

The Utility of Coronary CT Angiography in Evaluating Symptomatic Patients with Positive MPI Referred for Coronary Angiography: A Single-center Experience

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Abstract

Background: Patients with suspected or known coronary artery disease (CAD) can be challenging to evaluate. Our study aims to assess the efficacy and utility of coronary computed tomographic angiography (CCTA) as a diagnostic method in patients with abnormal myocardial perfusion imaging (MPI) who were initially referred for Invasive Coronary Angiography (ICA).

Methods: This is a single-center retrospective descriptive study. We evaluated 210 patients who underwent CCTA instead of ICA. Data of these patients were documented and analyzed accordingly.

Results: Of the 210 patients who underwent CCTA, the procedure was found to be diagnostic in 172 (81.9%) patients. Of these 172 patients, 152 (88.4%) had normal coronaries or minor CAD, and 20 (11.6%) had significant disease requiring subsequent ICA. In 38 (18.1%) patients out of the total cohort, the CCTA was not diagnostic or could not be performed due to technical difficulties, requiring either ICA or another ischemia evaluation diagnostic modality.

Conclusion: CCTA is a viable and reliable diagnostic tool for evaluating patients with suspected CAD referred for ICA following an abnormal MPI test. It is recommended as an initial test to rule out significant coronary stenosis and as it can avoid unnecessary ICA.

Keywords: CAD, CCTA, CVD, ICA, MPI

Introduction

Cardiovascular disease (CVD) is the world's leading cause of disease burden and a major cause of mortality. According to the Global Burden of Disease (GBD) Study 2019, the number of people living with cardiovascular disease has increased from 271 million to 523 million over the past 20 years, while the number of CVD-related deaths increased by almost 50% over the same time frame.[1] It is vitally crucial for physicians to diagnose coronary artery disease (CAD) as early and accurately as possible, yet this continues to be a challenging task.[2]

Despite its drawbacks, invasive coronary angiography (ICA) has long been the gold standard diagnostic method to detect CAD.[3] In the past few decades, however, non-invasive diagnostic methods for the evaluation of CAD have evolved. As CCTA and other imaging modalities progress, healthcare professionals must know how to integrate this new technology into daily clinical practice optimally.[4] Several studies and clinical trials supported using CCTA for identifying, defining, and stratifying the risk of CAD. [3] In this paper, we explore the utility of CCTA following abnormal myocardial perfusion imaging (MPI) in diagnosing coronary artery disease (CAD) and its role in preventing unnecessary Invasive Coronary Angiography (ICA). This study analyzed local data, which serves as evidence of the efficiency of CT and its role in diagnosing CAD.

Materials & Methods

Setting

This is a retrospective, descriptive, single-center study based in the Mohammed bin Khalifa Cardiac Centre (MKCC) in the Kingdom of Bahrain. We chose a cohort of 210 patients from January 2021 – December 2022 referred to our center following an abnormal MPI.

Study population

Our study included data from 210 patients. Inclusion criteria included age > 18 years, abnormal MPI test requiring ICA as an indication for referral, sending the patient for CCTA before ICA, and complete documentation of events. Anyone who did not fit our inclusion criteria was excluded from the study. Patients were selected by going through the CT records in the radiology department by identifying the indication of CCTA within the research period. Patients' characteristics, such as age at the time of referral and gender, were documented in their electronic medical records.

Clinical Definitions/Procedure

A Dual Source CT scanner (SOMATOM Force Siemens Healthcare) was utilized with 384 slices acquired. The reporting was done by a consultant specialized in diagnostic cardiac imaging or a senior resident, with subsequent discussion by an experienced supervising consultant. Minor disease was defined as 30-50% stenosis in one or more epicardial arteries. Significant disease was defined as any obstructive CAD (stenosis greater than 50%) that might require subsequent intervention like percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG).

Statistical analysis

The collection and tabulation of data adopted a standardized format. SPSS Statistics (version 20.0; IBM Corp.) software was used for statistical analysis and graph generation.

Results

A total of 210 patients were included in our study during the study period; 136 (64.8%) were females, and 74 (35.2%) were males, see Table 1. The mean and median age of the patients at the time of referral was 58 and 57.5, respectively.

Table 1: Study Demographics

Age	**Female** ***136*** ***100%***	**Male** ***74*** ***100%***
<50	23 *16.9%*	15 20.3%
50 – 59	57 *41.9%*	27 36.5%
60 – 69	40 *29.4%*	24 32.4%
70 – 79	15 *11.1 %*	5 6.7%
80 – 89	1 *0.7%*	3 4.1%
>90	0 *0%*	0 *0%*

Of the 210 patients in the study, 172 (81.9%) had a diagnostic CCTA. 152 (88.4%) of these patients had normal coronaries or minor CAD, and 20 (11.6%) had significant disease requiring subsequent ICA. Out of these 20 patients, 16 (80%) had significant disease on ICA requiring PCI or CABG. See Figure 1.

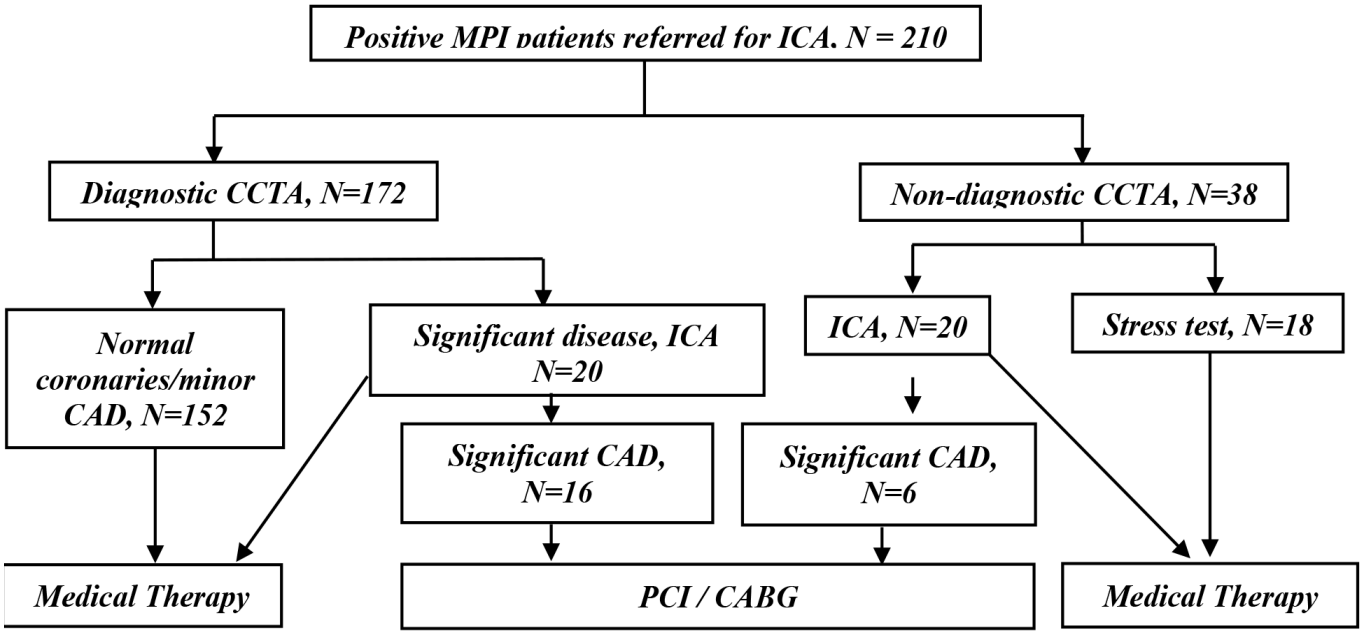

Figure-1: Study population and distribution

In 38 (18.1%) patients, CCTA was found to be non-diagnostic or sub-optimal to reach a diagnosis (See Figure-2).

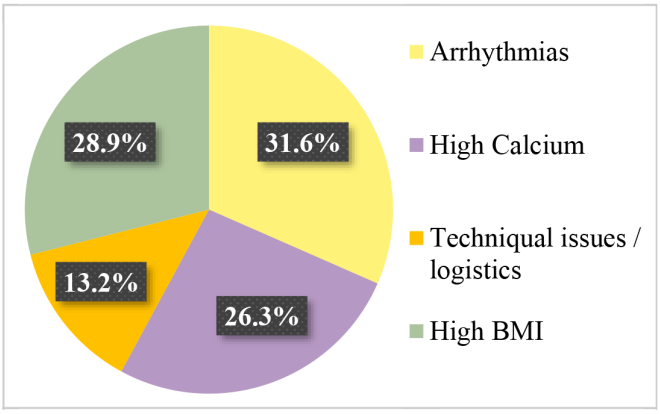

Figure-2: Causes of non-diagnostic CCTA

The most common reason for a non-diagnostic CCTA was found to be due to arrhythmias (N=12, 31.6%) such as frequent premature ventricular contractions (PVCs) and tachycardia, followed by high body mass index (BMI) (N=11, 28.9%). In some patients (N=10, 26.3%), CCTA was deferred due to high calcium. In addition, CCTA was not done due to logistical or technical issues in 5 cases (13.2%). Out of these 38 patients, 20 underwent subsequent ICA, and only 6 (30%) had significant disease. The remaining 18 patients underwent ischemia evaluation by Dobutamine Stress Echocardiogram (DSE) or Treadmill Test (TMT) and were discharged according to the results.

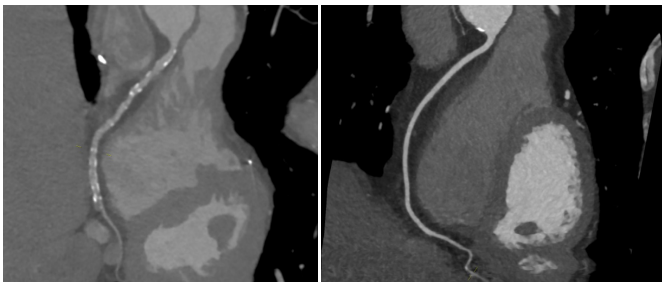

Figure-3: Picture A showing diffuse disease in the Right Coronary Artery (RCA). Picture B showing a normal vessel

Discussion

There has been limited data on which test is preferable in evaluating patients with suspected coronary artery disease (CAD). It's becoming evident that there may not be a single best test to evaluate such patients. Hence, more research is required. [2] Patients with abnormal MPI often need additional diagnostic testing or require subsequent diagnostic Invasive Coronary Angiography (ICA). Prior studies established that CCTA is effective in excluding significant CAD and may be used to determine the necessity for ICA, serving as a valid "gatekeeper" to invasive testing.[5]

This study highlights the role of CCTA in diagnosing CAD in individuals with an abnormal MPI test without further invasive diagnostic procedures. In a recent survey, Rudziński et al. [six] randomized 120 patients suspected to have CAD with indications of

ICA to undergo CCTA or direct ICA, they concluded that when compared to the direct ICA group, the number of patients who underwent subsequent invasive testing was reduced in the CCTA group by 64.4%. Similarly, our study showed that CCTA before ICA avoided unnecessary ICA in 88.4% of the patients referred for ICA. Furthermore, in the CCTA group of patients who had significant disease, ICA correctly documented significant disease on ICA in 80% of the subset, documenting the high accuracy of CCTA as a diagnostic tool. Only four patients (20%) did not have significant disease. As highlighted in Figures 3A and 3B, a CT scan is highly efficient in diagnosing a wide array of obstructive lesions in coronary arteries ranging from completely disease-free vessels to diffuse and significant stenosis.

There have been substantial advancements in CCTA, yet CTA remains a challenging standard of care. An important element for high-quality CCTA images is maintaining a controlled heart rate with proper electrocardiogram (ECG) gating and timing of contrast administration[9]. Our findings indicate that arrhythmias like uncontrolled heart rate and numerous premature ventricular contractions are the most common cause of non-diagnostic CCTA. Hence, it is crucial to establish a controlled heart rate before the procedure. Most patients are given oral beta blockers the day before the process and are loaded with oral and IV propranolol on the day of the procedure.

In addition, the radiation exposure from CCTA is a severe concern. CT technology has advanced dramatically over the years, allowing for much lower radiation exposure without sacrificing image quality[8]. Our study showed that the average radiation dose used in CCTA was 4.5 ± 2 mSv, similar or even lower than that of invasive coronary angiography.[7] This highlights that CCTA is safer regarding the radiation dose and potentially the adverse effects of the radiation.

Conclusion

Coronary angiography (CCTA) is a viable and reliable diagnostic tool for evaluating patients with suspected coronary artery disease (CAD). Moreover, CCTA is a cost-effective, first-line test that assists in identifying obstructive CAD and can be used to guide management decisions, significantly reducing unnecessary invasive coronary angiograms ICAs.

Limitations

Since this research was conducted at a single center, more extensive research is needed to determine the exact implications of CCTA. Other limitations include referral bias and the retrospective design.

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