ORIGINAL ARTICLE

Utilization of coronary computed tomography angiography for rapid risk stratification in emergency chest pain units

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Background: Coronary computed tomography angiography (CCTA) is a well-known method for evaluating anatomic coronary stenosis, but the reliability of CCTA to predict cardiovascular events is an issue of controversy. **Materials and Methods:** In this prospective observational study, 58 patients with acute chest pain and low-to-moderate risk were selected and CCTA was performed on them. During follow up, the occurrence of major adverse cardiac events (MACE), defined as, cardiac death, myocardial infarction or coronary revascularization, were evaluated. Sensitivity, specificity, and positive and negative predictive values of CCTA for the occurrence of MACE, at the six-month follow up, were also evaluated. **Results:** A total of nine (15.5 %) were positive in terms of the MACE criteria and they all had positive CCTA results. It seemed that there was 100% sensitivity for CCTA in predicting the occurrence of MACE. Forty-nine patients had no MACE, among whom 48 patients had negative CCTA. The specificity of CCTA in predicting the occurrence of MACE was 98%. All patients with positive CCTA showed significant stenosis in angiography. **Conclusion:** It appears that CCTA allows us to predict the prognosis of patients with acute chest pain and low-to moderate-risk in terms of MACE occurrence.

Key words: Computed coronary tomography angiography, major adverse cardiac events, prognosis

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INTRODUCTION

The evaluation of patients with acute chest pain, a discomfort with a squeezing pressure or burning sensation in the substernal or pericardial or pericardial region, is one of the major issues in medicine. The percentage of people with chest pain, who visit the Emergency Department, is increasing. Emergency physicians should have extreme caution when evaluating these patients. The short-term mortality rate of patients who are wrongly discharged from the Emergency Department is about 25%.[1] It is believed that about 2-8% of the patients who are discharged from the Emergency Department have unstable angina or myocardial infarction.[2] Therefore, observation of all patients presenting to the Emergency Department with acute chest pain does not seem logical and economical. Based on the mentioned information, we need reliable diagnostic tests to evaluate these patients and risk-stratify them in the Emergency Departments. An electrocardiogram (EKG) and cardiac enzyme measures are the basic traditional methods used as the first diagnostic step. Most cardiac centers are focused on stress survey (exercise treadmill test, myocardial perfusion imaging or stress echo) to look for functional ischemia. However, these are indirect methods and also suffer from high false positive and false negative results. Several studies have tried to determine diagnostic tests that can predict early and late prognosis of these patients.[5]

Coronary computed tomography angiography is a new method for evaluating MACE, which is defined as cardiac death, myocardial infarction or coronary revascularization. For example, in one study, CCTA, when compared with invasive coronary angiography, has shown high sensitivity and specificity in the detection of clinically significant coronary artery disease. It is proposed that CCTA has a high negative predictive value for ruling out the acute coronary syndrome (ACS) and predicting major adverse cardiac events in patients with acute chest pain.[6-9]

Also some studies have evaluated the prognostic utility of computed tomography (CT) in patients with

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Coronary Artery Disease (CAD) for predicting MACE and mortality. These studies have proposed that patients with severe CAD, such as stenosis, have a significant risk of a worse outcome. They are long-term retrospective observational cohorts, where CT results have been employed to guide management.[10-14] Although there have been some studies on the importance of CCTA, no study has evaluated this issue in a one-year follow-up of patients for MACE.

The aim of this study is to evaluate the diagnostic value of CCTA in determining the prognosis of patients with low-to-intermediate risk of acute chest pain in terms of the incidence of MACE.

MATERIALS AND METHODS

Study design and patients

This was a prospective descriptive study, which was conducted in a teaching hospital (St. Alzahra Hospital, Isfahan, Iran) during 2011-2012. This study was approved by the local ethical committee, and patients enrolled in the study after signing a consent form (Research Project Number 390357).

Procedures

A total of 58 consecutive patients with acute chest pain and low-to-moderate risk [defined in Table 1], admitted to the University Referral Teaching Hospital, the Alzahra Hospital, were evaluated. The exclusion criteria included: Stable arrhythmias, hemodynamic instability, clinical history of drug allergy, renal failure, pregnant women or women in childbearing age who did not use preventive method, β-Blocker contraindications, and a recent diagnosis of coronary disease (less than a month), which all were asked in a questionnaire. After taking the history and after clinical evaluation, all the patients underwent CCTA. Invasive angiography was performed on the patients who had coronary artery stenosis of more than 50% in their CCTA. We also evaluated changes in cardiac enzymes. Cardiac enzymes (CPK MB, troponin) were checked serially every three hours. An EKG was performed on admission and repeated every 20 minutes, for one hour. Subsequently, the patients were under cardiac monitoring during hospitalization.

All the patients were followed up for one year. The frequency of MACE criteria were evaluated, to determine the value of CCTA in determining the prognosis of the patients. MACE was defined as death, myocardial infarction, unstable angina, and cases that required target vessel revascularization (TVR). Sensitivity, specificity, and positive and negative predictive values of CCTA for the occurrence of MACE, at follow-up, were calculated. The results were reported by the cardiologist and follow-up was performed by the Emergency Medicine specialist.

SPSS 20 was used for statistical analysis. For prediction of specifity and sensitivity, the McNemar test was used.

RESULTS

Fifty-eight patients with a mean age of 56.5 ± 10.4 years (range: 40-87) were evaluated. MACE was more common in males (56.9%. The clinical and paraclinical data of patients are listed in Table 2. Ten (17.2%) patients had more than50% coronary stenosis on CCTA (positive CCTA). Invasive coronary angiography confirmed it for eight patients. During the follow-up period, nine (15.5%) patients experienced MACE [Table 3]. All nine patients had positive CCTA. Also among 49 patients, who had no MACE, 48 patients had negative CCTA. The sensitivity, specificity, and positive and negative predictive values of CCTA in predicting the occurrence of MACE was: 100, 98, 90, and 100%, respectively. The mean duration of hospitalization was 34.63 ± 21.50 hours. The mean of follow up was 14 months (range 6 to 22 months). No mortality was observed.

Table 1: Likelihood that signs and symptoms represent an acute coronary syndrome[15]

Features	High likelihood (any of the following)	Intermediate likelihood (Absence of high-likelihood feature) and presence of any of the following	Low likelihood (Absence of high or Intermediate-likelihood features, but may have any of the following
History	Chest or left arm pain or discomfort as chief symptom reproducing prior documented angina Known history of coronary artery disease, inducing myocardial infarction	Chest or left arm pain or discomfort as chief symptom Age>70 years Male sex Diabetes mellitus	Probable ischemic symptoms in adolescence with any of the intermediate likelihood characteristics
Examination	Transient mitral regurgitation, hypotension, diaphoresis, pulmonary edema or rales	Extra cardiac vascular disease	Chest discomfort reproduced by palpation
EKG	New or presumably new transient ST segment deviation (>0.05 minute) or T-wave inversion (>0.2 mv) with symptoms	Fixed Q waves Abnormal ST segments or T-waves Not documented to be current	T-wave flattening or inversion in leads with dominant R waves Normal EKG
Cardiac Markers	Elevated cardiac TnI, TnT or CKMB	Normal	Normal

Table 2: Clinical and paraclinical data of patients

Variables	Number (%)
Risk Factors	
Hypertension	27 (46.6)
Hyperlipidemia	23 (39.7)
Diabetes	20 (34.5)
Use of tobacco	29 (50)
Positive family history of cardiac disease	15 (25.9)
Angina	
Typical	44 (75.9)
Atypical	9 (15.5)
Heart rhythm	
Sinus	57 (98.3)
AF	1 (1.7)
Bundle branch block	
RBBB	6 (10.3)
LBBB	1 (1.7)
Q wave	10 (17.2)
ST-T changes	19 (32.8)
Ejection fraction	
Severe (<30%)	1 (1.7)
Moderate (30-45%)	1 (1.7)
Mild (45-60%)	4 (6.9)
Normal (>60%)	52 (89.7)
Cardiac enzyme	
Abnormal troponin	9 (15.5)
Abnormal CKMB	14 (24.1)

(1) Presence of chest pain or (2) discomfort that was provoked by exertion or stress, and (3) relieved by rest and / or nitroglycerin. Chest pain was called 'typical' angina if patient had all three criteria and atypical or non-anginal if less than three criteria were present (Am J Cardiol. 2010 Jun 1;105(11):1561-4. Emergency Medicine Education journal)

Table 3: Major adverse cardiac events during the follow-up period of study

MACE	Number (%)
Cardiac death	0
MI	0
Unstable angina	5
Target vessel revascularization	11

MI=Myocardial Infarction

DISCUSSION

This study showed that the sensitivity and negative predictive value of CCTA for the occurrence of MACE criteria was 100%. Besides, negative CCTA (coronary stenosis below 50%) can predict that MACE will not occur for the next six months.

Min *et al*.[10] found that stenosis over 70% could be a good predictor for the occurrence of MACE. This study was conducted on 172 patients, who were followed for an average of 22 months. The incidence of MACE criteria was significantly greater in the group with coronary artery stenosis, as compared to the group that did not have stenosis. In our study, we did not compare two groups with positive and negative CCTA, but among those who had negative CCTA, no one had MACE, and all those with MACE had positive CCTA.

Hollander *et al*.,[4] in a study on 54 patients with low-risk acute chest pain, reported the incidence of cardiovascular events in a 30-day follow-up; in this study all 54 patients underwent CCTA and patients who reported negative CCTA results were immediately discharged from the Emergency Department. Within 30 days, they were followed for occurrence of death and myocardial infarction. Approximately 46 of these patients were discharged from the Emergency Department after CCTA, and none had cardiac complications at 30 days. The results of this study showed that in patients with low-risk acute chest pain, CCTA could grant permission to discharge the patients quickly. In our study, the patients were followed for a longer period our results were consistent with their results, which showed that none of the patients with negative CCTA had MACE.

Hoffmann *et al*.[8] studied CCTA in comparison with the standard method in patients with acute coronary syndrome. In this multicenter trial, 1000 patients with the acute coronary syndrome, who had no evidence of ischemia on EKG or troponin, were evaluated. The primary objective of this study was the length of stay in hospital.

The other objective of this study was the incidence of MACE at 28 days and discharge from the Emergency Department. The duration of hospitalization in the group that underwent CCTA was 7.6 hours less than the group that was treated with the standard method. The number of patients who were discharged directly from the Emergency Room in the CCTA group was significantly more than that in the standard group. No significant difference in the incidence of MACE was found in both groups after 28 days and also the mean hospital costs were similar in both groups. The result of this study showed that usage of CCTA for triage of patients presenting to the Emergency Department with ACS symptoms could improve the clinical decision. Our study was smaller in sample size than that of Hoffman *et al*. and also we did not perform a comparison for evaluation of patients with acute chest pain, with the standard method and CCTA, in our hospital. Our study only described the incidence of MACE in patients who underwent CCTA and concluded that a negative CCTA result in patients with acute chest pain and low and intermediate risk, could strongly predict that MACE would not occur.

Schlett *et al*.[11] studied the two-year prognostic value of a cardiac CT scan, to predict the occurrence of MACE in patients presenting to the Emergency Department with acute chest pain. In their study 368 patients, with a mean

age of 53 years, who had been admitted to the Emergency Department with acute chest pain, negative troponin, and normal EKG, had enrolled for two years. Follow-up was completed for 333 patients and 25 patients experienced 35 MACE criteria. In this study, the mortality rate was zero, while 12 cases of myocardial infarction and 23 cases of revascularization occurred. They concluded that coronary artery disease (CAD) was detected by CCTA, which predicted that MACE would not occur for two years, while CCTA stenosis was associated with a high risk of MACE. However, our results are especially consistent with this study.

Some other studies showed that in different patients the absence of CAD by CT, predicted that MACE would be absent in a follow-up period of ≤60 months.[13,14,16]

In another study, the evaluation of patients presenting to the Emergency Department with acute chest pain was done with CCTA. In this observational study of 368 patients, with a mean age of 53 years, 31 patients (8%) patients had ACS. Among them, 50% of the patients were free of coronary heart disease, 31% had non-obstructive coronary disease, and 19% had significant coronary artery narrowing. In this study, the sensitivity and negative predictive value for ACS in case of negative CCTA was 100%. The findings showed that 50% of the patients with low and intermediate risk did not have ACS, so the immediate performance of CCTA in these patients could help in clinical decision-making, however, besides calculating the sensitivity and specificity, and positive and negative predictive values of CCTA, the likelihood ratios were calculated for this test.[12] We only studied the sensitivity and specificity, and predictive value of this diagnostic technique; the sensitivity and the negative predictive value of CCTA in our study was 100% too. The Rule out Myocardial Infarction Using Computer Assisted Tomography (ROMICAT) trial was a prospective, double-blind observational study, which included 368 patients with acute chest pain and a low-to-intermediate risk of ACS. In this trial, 50% of the patients had no coronary atherosclerosis on CT, did not have ACS during hospitalization or MACE during the 60-month follow up.[17] Thus, the normal finding on CT, with no evidence of coronary atherosclerosis, changed the disposition decision of physicians in the patient population.[18]

Also the long-term effects of CT radiation in terms of more widespread use of this equipment should be kept in mind and evaluated before any guideline change.[19]

Data from the previous trial and other observational studies showed that cardiac CT angiography is a valuable diagnostic evaluating tool in the early triage of patients with chest pain[20-25] however, multicenter, randomized trials in ED patients are needed to answer whether this study is a cost-effective strategy when compared with the standard modalities.

In conclusion, it seems that CCTA allows us to predict the prognosis of patients with acute chest pain and low-to-moderate risk, in terms of MACE occurrence.

Limitations of the study: This study was a single center study with a limited number of patients and a limited time of follow up. For more robust recommendations we still need long-term follow ups and larger studies, with more patients included, in more than one center.

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