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"Triple Rule Out" CT scan in Emergency Department Patients

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ABSTRACT

Background: Although conventional coronary angiography is the gold standard tool of diagnosing coronary artery disease (CAD), it is an invasive procedure, and it can miss non-coronary causes of acute chest pain. Triple role out CT has emerged as a promising tool for assessment of such cases. Herein, we present our experience in comparing "triple out CT" as a diagnostic tool for acute chest pain patients. **Objective:** The aim of the current study was to assess the validity and efficacy of triple rule-out CT in diagnosis of different vascular causes of chest pain in the Emergency Department. **Patients and methods:** The data of 50 patients with an intermediate risk for CAD were retrospectively reviewed. All of them underwent the triple out protocol, and when coronary cause was established, conventional angiography was done. **Results:** CT angiography (CTA) revealed CAD in 29 (58%) subjects, while non-coronary disease was detected in 12 (24%) patients. The remaining nine subjects had negative CTA study. In the patients diagnosed with CAD, most of them had severe disease (82.8%), whereas the remaining five patients had moderate one. Findings rather than CAD included pulmonary embolism, mediastinal mass, acute aortic disease, pulmonary disease, hernia, and pulmonary artery aneurysm. There was a significant relation agreement between CTA and cardiac catheterization regarding the severity of CAD (P<0.001). **Conclusion:** Triple out CT could be a surrogate diagnostic modality for patients with acute chest pain, even when CAD is suspected. It can yield comparable results compared to the conventional coronary angiography. Therefore, its application is widely recommended in low-source emergency settings.

Keywords: Acute chest pain, Triple out CT, Coronary angiography.

INTRODUCTION

Acute chest pain is one of the most common causes of emergency department visits [(1)]. It ranks the second following abdominal pain [(2)]. As acute chest pain has a wide differential diagnosis, it represents a major diagnostic challenge for emergency care physicians [(3)]. Although it has benign and simple etiologies, it could be the manifestation of life-threatening conditions including myocardial ischemia, thoracic aortic dissection, or pulmonary embolism [(4,5)].

Coronary artery disease (CAD) is one of the most common and serious causes of chest pain [(6)]. Although conventional coronary angiography is the gold standard investigation in assessment of such pathology, it is an invasive technique that carries some risk of complications [(1)]. Besides, it does not assess other causes of chest pain that might be serious as well [(7)].

Multiple reports have confirmed the efficacy of coronary CT angiography in excluding significant coronary stenosis [(8-10)]. In addition, the "triple rule-out protocol" can assess other causes of life-threatening chest pain beside coronary ischemia, using the 64-slice MDCT device, with a single breath hold [(2,11,12)]. This protocol has been widely used as it is not invasive compared to the conventional cardiac catheterization, and it could also assess other intrathoracic structures in a single scan [(13)].

Herein, we present our experience in comparing "triple out CT" as an alternative diagnostic tool to the conventional coronary angiography in assessment of patients with acute chest pain. The aim of the current study was to assess the validity and efficacy of triple rule-out CT in diagnosis of different vascular causes of chest pain in the Emergency Department.

PATIENTS AND METHODS

We retrospectively reviewed the data of consecutive 50 patients who presented with acute chest pain to our Emergency Department at Sohag University Hospitals, during the period between January and December 2021.

We included patients classified to have an intermediate risk for acute coronary syndrome (ACS), according to the TIMI score (scores between 3 and 5) [(14)]. Contrarily, we excluded patients with high risk (TIMI score >5), pregnancy, high creatinine level (>1.2 mg/dl), and who reported previous allergy to the contrast media. Patients with traumatic chest pain were also excluded.

All patients were subjected to detailed history taking, physical examination and routine laboratory investigations. The triple out CT protocol in the current study was performed via a 128-multislice CT device using a 0.5 mm Detector-row dimension, 0.35 s gantry rotation, 160 mm beam width, and 175 s temporal resolution for each cross-section image.

Five minutes prior to the CT examination, 5 mg of sublingual nitroglycerin was commenced for all cases to obtain sufficient coronary vasodilation, and if the patient had a heart rate more than 65 bpm, intravenous metoprolol (5-15 mg) was administered. This was done to decrease the heart rate in order to enhance the imaging quality. Continuous hemodynamic monitoring

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was ensured for all subjects to detect any cardiovascular complications of the previous two medications.

Initially, a non-contrast CT examination of the whole chest was performed to assess aorta, pulmonary tissues and to detect significant coronary calcifications. Then, following the "biphasic dual flow injection protocol", a double syringe injector was used to inject 95 ml of the contrast media through a 16- or 18-gauge cannula inserted in a suitable large antecubital vein. At first, 75 ml of the contrast was injected; thereafter the remaining 25 ml were administered along with 25 ml of normal saline, with a flow rate of 5 ml per second.

The diagnostic vessel opacification was determined using the bolus-tracking technique, in which the first and second injection phases were applied to opacify the coronary and pulmonary vessels respectively. We used either prospectively ECG-triggered or retrospectively ECG gated acquisition methods, according to patients' age and hemodynamics. The scan started from the clavicular inferior margin down to the heart base, using a 0.5 ml thickness images.

Complex advanced software programs were applied for post-processing reconstruction. Images with optimum quality were used for the reconstruction, with a section thickness of 2 mm and an overlap of 0.5 mm.

Occasionally, some larger sections were used for noise reduction. Regarding post-processing techniques, we applied multiplanar reformation, curved multiplanar reformation, maximum intensity projection, as well as volume rendering.

Following the triple out CT examination, major adverse cardiac events and other diagnoses were reviewed during the next two months. This was gathered from patient medical records or contact with a telephone call. Additional symptoms, such as chest pain, other illnesses, and hospitalizations, were asked about. Other cardiac and non-cardiac tests or procedures, such as stress testing, cardiac echocardiography, cardiac catheterization, and coronary artery bypass grafting, were asked about by patients.

Ethical approval:

This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Sohag University. Written informed consent was obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical analysis:

The collected data were introduced and statistically analyzed by utilizing the Statistical Package for Social Sciences (SPSS) version 24 for windows. Qualitative data were defined as numbers and percentages. Chi-Square test and Fisher's exact test were used for comparison between categorical variables as appropriate. Quantitative data were tested for normality by Kolmogorov-Smirnov test. Normal distribution of variables was described as mean and standard deviation (SD), and independent sample t-test/Mann Whitney test was used for comparison between groups. P value ≤0.05 was considered to be statistically significant.

RESULTS

Table 1 illustrates the sociodemographic and clinical characteristics of the participants.

Table (1): Patients baseline characteristics and risk factors.

Variable	Frequency	Percentage
Smoking	37	74
Diabetes	17	34
Hypertension	13	26
Obesity	17	34
Hyperlipidemia	19	38
Family history of CAD	13	26

Table 2 summarizes CTA of the studied patients in the current study.

Table (2): Results of CT Angiography of the study's participants.

Variable		Frequency	Percentage
Diagnosis	**Negative**	9	18
	Coronary artery disease	29	58
	Non coronary disease	12	24
Degree of coronary artery disease by CTA	**Moderate**	5	17.2
	Severe	24	82.8
Non-coronary positive findings	**Acute aortic disease**	4	19
	Acute pulmonary embolism	6	28.6
	Hernia	2	9.5
	Pulmonary disease	3	14.3
	Mediastinal mass	4	19
	Pulmonary artery aneurysm	2	9.5

Table 3 summarizes the degree of CAD of the studied patients after catheterization.

Table (3): Degree of coronary artery disease by catheterization.

Variable	Frequency	Percentage
Mild	2	6.9
Moderate	10	34.5
Severe	17	58.6

There was a significant relation agreement between CTA and cardiac catheterization regarding the severity of CAD (**Table 4**).

Table (4): Relation between degree of coronary artery disease by CTA and Catheterization.

Degree	Moderate	Severe	P-value	Kappa
Mild	2	0	**<0.001**	0.489
Moderate	5	5		
Severe	0	17		

Table 5 illustrates results of follow up of CAD patients included in our study.

Table (5): Follow-up results of the study's participants.

Variable		Frequency	Percentage
Follow-up results	**Discharge**	27	54
	Admission	23	46
Follow-up cardiac investigations	**None**	24	48
	Stress tests	4	8
	Invasive angiography	22	44

DISCUSSION

This study was conducted to "triple out CT" as an alternative diagnostic tool to the conventional coronary angiography in assessment of patients with acute chest pain. This diagnostic method was able to detect coronary disease in 29 (58%) patients, of whom, 24 had severe CAD, while the remaining had moderate degree disease.

In another Egyptian study conducted at Tanta University, triple out CT was able to detect CAD in 57.7% of patients (26 cases) in the included sample of patients with chest pain. Severe stenosis was detected in 10 patients, while eight patients had moderate stenosis. The remaining eight cases had insignificant stenosis [(1)]. Soliman also reported that the same finding was diagnosed by the same modality in 50% of the included participants who had low to intermediate risk [(15)]. However, **Kevin and co-workers** reported that only 11% of their cases had CAD [(16)], and this could be explained by the 64-multislie CT machine they used in this study.

When comparing CTA with the conventional angiography technique in the current study, there was a significant correlation between the two modalities (P<0.001), as both of them agreed in most moderate and severe findings. **Johnson and co-workers** confirmed the previous findings, as triple out CTA had sensitivity and specificity of 100% and 99% in evaluating coronary artery lesions (17). Additionally, **Litmanovich and co-workers** reported that the weighted kappa factor was 0.79 indicating a significant agreement between triple out CT and catheter angiography [(18)]. An additional study also noted that the same CT protocol had sensitivity, specificity, and accuracy of 94%, 77% and 87%, respectively [(19)].

Furthermore, another study found no difference in the percentage of patients diagnosed with CAD using the same CT protocol versus coronary angiography (13.2% vs. 16.1%, P=0.22). However, the authors did not provide the diagnostic accuracy values when the two modalities were compared [(20)].

All of the previous studies could confirm that triple out CT could be a surrogate diagnostic modality for coronary stenotic lesions. Conventional angiographic examination should be performed in suspicious cases, in whom the clinical and laboratory criteria coincide with coronary disease despite normal CTA findings. Depending on CT as the primary assessment method would save time and money, and it will also decrease the incidence of missed patients having CAD who would suffer from negligence as no diagnosis has been reached due to long list scheduled for catheterization [(21)]. In addition, application of conventional angiography has some geometrical limitations leading to either over-or under-estimation of the degree of stenosis in about 33% of patients [(22)].

In the current study, other findings rather than CAD included pulmonary embolism, mediastinal mass, acute aortic disease, pulmonary disease, hernia, and pulmonary artery aneurysm. In another similar study, non-coronary causes of chest pain included acute aortic disease (8.8%), pulmonary embolus (6.6%), hernia (4.4%), pulmonary nodule (2.2%) and pulmonary disease (2.2%) [(1)]. In addition, Thomas and his associates reported other causes including pleural effusion, pneumonia, and left ventricular hypertrophy [(23)].

It is expected to find some differences between different studies regarding the non-coronary etiologies of chest pain, along with their incidence. That could depend on the sample size included, criteria of the CT device, and epidemiological criteria of the geographical region. However, this should alert physicians to the fact that not all acute chest pain is caused by CAD, and a respectable percent is caused by other pathologies. This should alert us to the vital importance of triple out CT in assessment of patients presenting with acute chest pain, especially when CAD is doubtful.

This study has some limitations; it included a relatively small number of patients who were collected from a single institute. Therefore, more studies including more patients from different radiology and emergency centers should be conducted.

CONCLUSION

Triple out CT could be a surrogate diagnostic modality for patients with acute chest pain, even when CAD is suspected. It can yield comparable results compared to the conventional coronary angiography. Therefore, its application is widely recommended in low-source emergency settings.

Conflict of interest: The investigators declare no conflict of interest.

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